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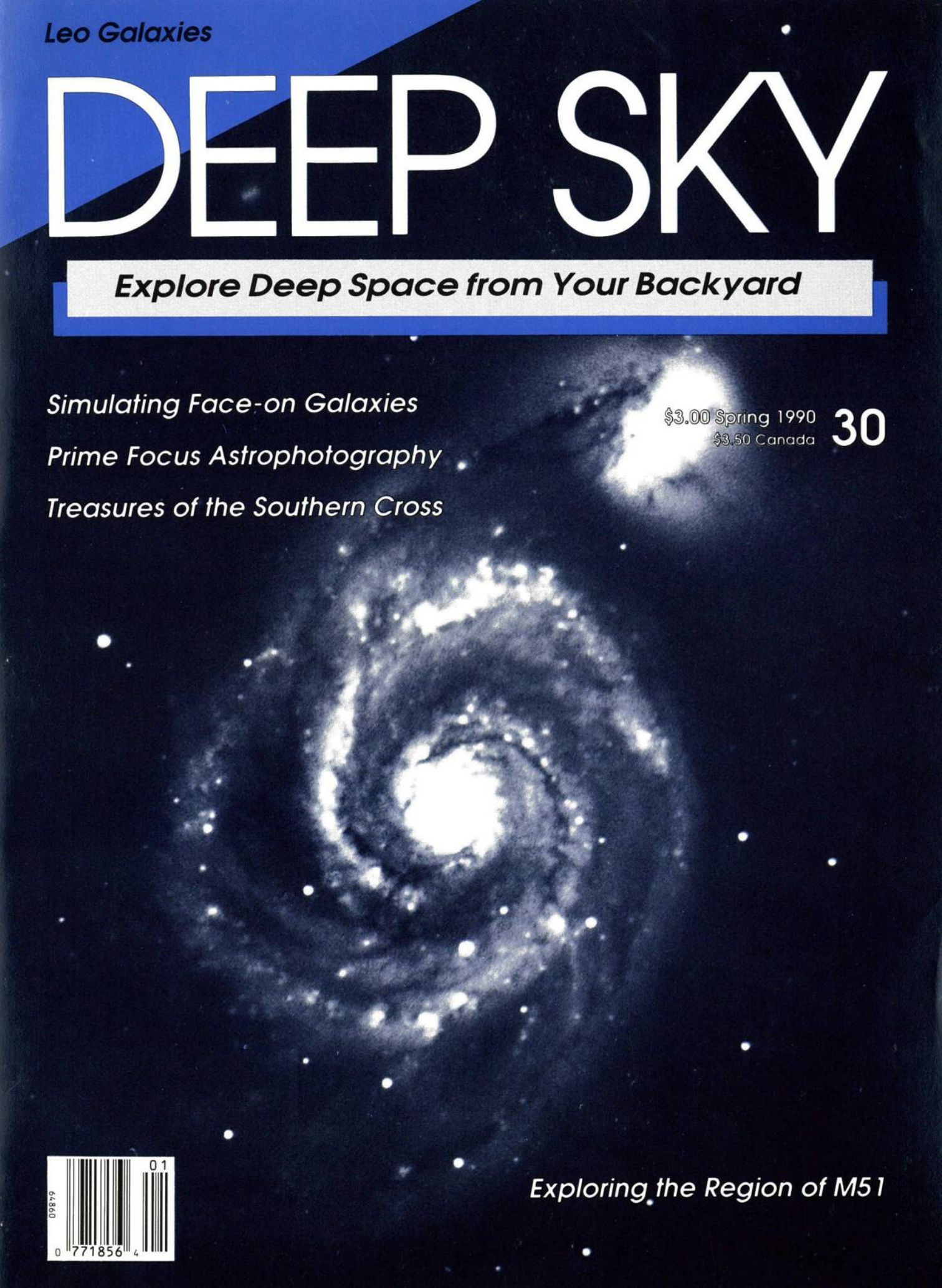

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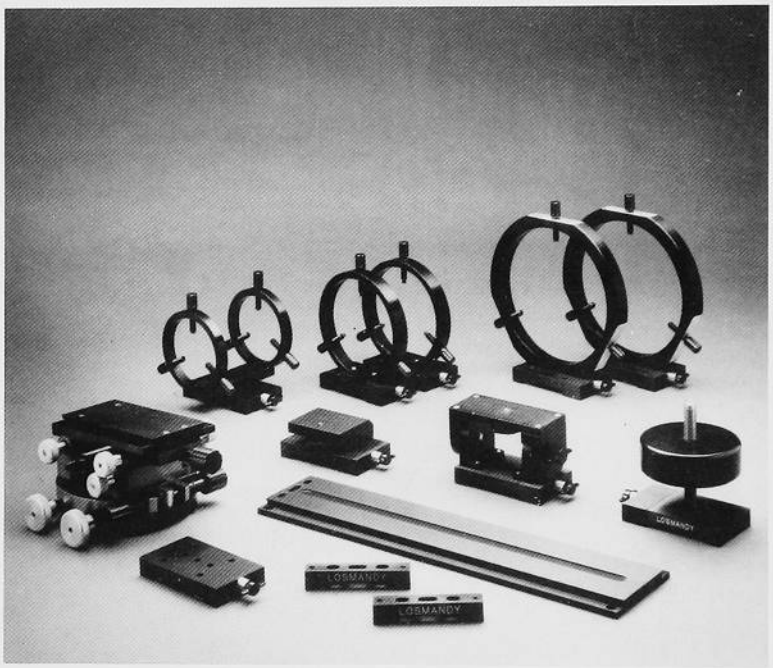

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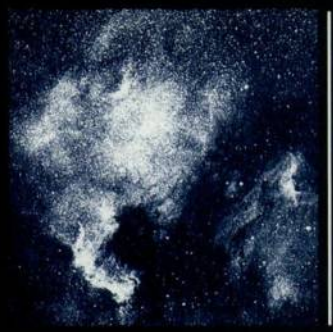
FOUNDED IN 1977 BY DAVID J. EICHER

SPRING 1990 VOLUME 8, NUMBER 2



Prime Focus Astrophotography with Newtonians
by Chris Schur
10 *Common Newtonian reflectors are perhaps the most effective photographic telescopes. Expert astrophotographer Chris Schur tells how to realize your photo potential.*

Exploring the Region of M51
by Robert Bunge
16 *Virtually all deep-sky observers have marveled at the graceful spiral arms of the Whirlpool Galaxy, M51. But have you observed the lesser-known galaxies that surround it?*

An Update on Galaxy Tilting
by Alan Goldstein
22 *Most galaxies lie at inconvenient orientations for study. Galaxy researcher Alan Goldstein describes a photographic technique that lets us see galaxies as they would appear face-on.*

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Three Weeks in Paradise

Cover: The Whirlpool Galaxy, M51, photographed by Tony Hallas and Daphne Mount, with a 14-inch f/10 SCT, hypered Tech Pan film, and a 60-minute exposure.
Opposite page: M100 photographed by Chris Schur with a 14-inch f/5 reflector, hypered Tech Pan film, and a 45-minute exposure.

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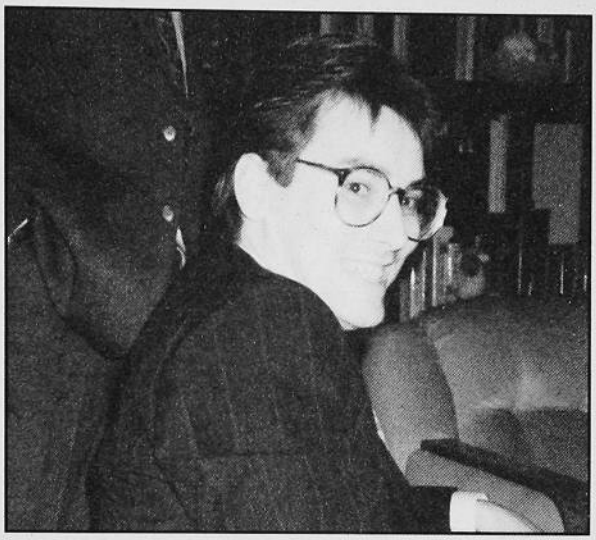
At the Eyepiece
Like It or Not, It's Galaxy Time Again



Attempting to warm up, Brookfield, Wisconsin, Winter 1990.

Like it or not, it's galaxy time again. Time to roll out the telescope and start picking off each and every member of the Virgo Cluster, one by one. Time to start developing your eye's ability to perceive faint details like spiral arms and faint, outer haloes. But most of all, it's time for the return of warmer weather, at least for us northern-hemisphere types. That means an end to the bone-chilling cold that turns us into hibernating fools for three months each year (six months in Wisconsin).

To celebrate the return of observing weather, we've expanded the current issue to 56 pages and stuffed it with information on a wide range of deep-sky objects. Chris Schur's feature article explains how to produce stunning deep-sky photos with a simple Newtonian reflector.Robert Bunge explores the array of faint, virtually unknown galaxies that surround the big spiral M51 in Canes Venatici. In the third feature, Alan Goldstein provides an update on his long-term project of photographically correcting galaxies to simulate their face-on appearances. His latest batch of test photographs shows a group of old familiar faces in an astonishingly new way.

Our departments include articles on the open clusters in the Southern Cross by Australian observer Stephen Pattie; an assessment of the value of the Uppsala General Catalogue of Galaxies by Robert Bunge; a beautiful portfolio of sketches showing galaxies in Leo by the talented observer Michael Sweetman; and a journey through the sketchbook of Australian observer Gerd Barth-Vollrath. We hope that you will enjoy this sampling of what's happening in deep-sky astronomy.

As temperatures warm and ground thaws, let us know what you're up to. Send your photos, sketches, and articles to me and we will be happy to include them in future issues.

Yours truly,

Dave Eicher
Editor-in-Chief

Letters to *Deep Sky*
Messier Marathons Reconsidered

Messier Marathons Reconsidered

Dear Dave / I was amused to read G. Jan de Vries' letter in *Deep Sky* #28. Although I tend to agree with him about the general lack of usefulness in Messier Marathons, I also agree with those who find such activities fun.

There are some advantages to marathoning that I mentioned in my January 1982 *Deep Sky Monthly* article about constellation mopping. In that article I said: "At first glance it may seem that such an effort may be observationally useless — more like getting a high score on 'Space Invaders' than doing serious observing. But something else is going on, too. In the space of a few hours you get to see and compare every (or nearly every) Messier object. Do you often compare your winter and summer favorites side by side? I don't."

In his article in the March 1982 *Deep Sky Monthly*, Brent Archinal pointed out that this can be an excellent activity to motivate inactive club observers. Marathons provide a structured, goal-oriented activity for observing programs that are stuck in a rut of setting up the telescope and looking at the same showpiece objects month after month. Marathons are necessarily confined to a tiny window in the early springtime. At most they are a once-a-year fling. We can put aside our detailed observing logs and have a brief blowout, a "rite of spring" as a celebration.

If this were all an observer did I would agree that it would indeed resemble madness. But for the most part, marathons are annual aberrations, and once observers get a few under their belts, they lose interest.

I don't know who started this myth that star was the only "official" style of marathoning allowed, but in the early days we made no distinctions. I participated in what was, I believe, the first large-telescope Messier Marathon, which was held on March 15, 1980. We observed 107 objects through the 32-inch Cassegrain reflector at Perkins Observatory in Delaware, Ohio. Finding objects using huge, accurately aligned circles was so simple that we thought nothing of it. The observing of the objects was what we concentrated on. In fact, this really is the way to do a Messier Marathon if you want more than a glance at the objects. Effortless finding leaves five minutes per object free for observing. This may not sound like much, but try looking at a single object for a measured five minutes next time you're out.

I advise Mr. de Vries to realize that most people do deep-sky observing for the fun of it. Few observe with any scientific goal in mind. Even astrophotographers freely admit that the professional observatories produce better results. Telling people how to observe is a pointless endeavor. They observe for enjoyment, and if Messier Marathons give them pleasure, we should only approve. Come on Mr. de Vries, lighten up!

Dick Suiter
425 East 19th Street #106
Panama City, FL 32405

Dear Dave / I have just received my first issue of *Deep Sky* and read with interest G. Jan de Vries' letter on Messier Madness. I think Mr. de Vries sells the satisfaction of observing short. It is evident that he feels only time spent actually looking at an object is of value.

I, however, value and enjoy the hunt as much as the time spent viewing the object. I ask Mr. de Vries that he not try to limit my fun. New observers should decide for themselves what segments of this wonderfully diverse hobby are enjoyable and worth pursuring. I shudder to think of Mr. de Vries' reaction to the time I waste grinding mirrors!

Stephen M. Hopkins
Toledo Astronomical Association
21601 Pemberville Road
Luckey, OH 43443

Where's the Nova?

Dear Dave / In the chart accompanying my article in the Autumn 1989 *Deep Sky*, readers were swindled out of nearly half of their novae. The region in Sagittarius and Scorpius around the galactic center appears nearly blank. In fact, as the text suggests, it is packed with novae. An inset map, which was omitted, was to have shown the missing novae.

Peter Collins
7440 East Thomas #214
Scottsdale, AZ 85251

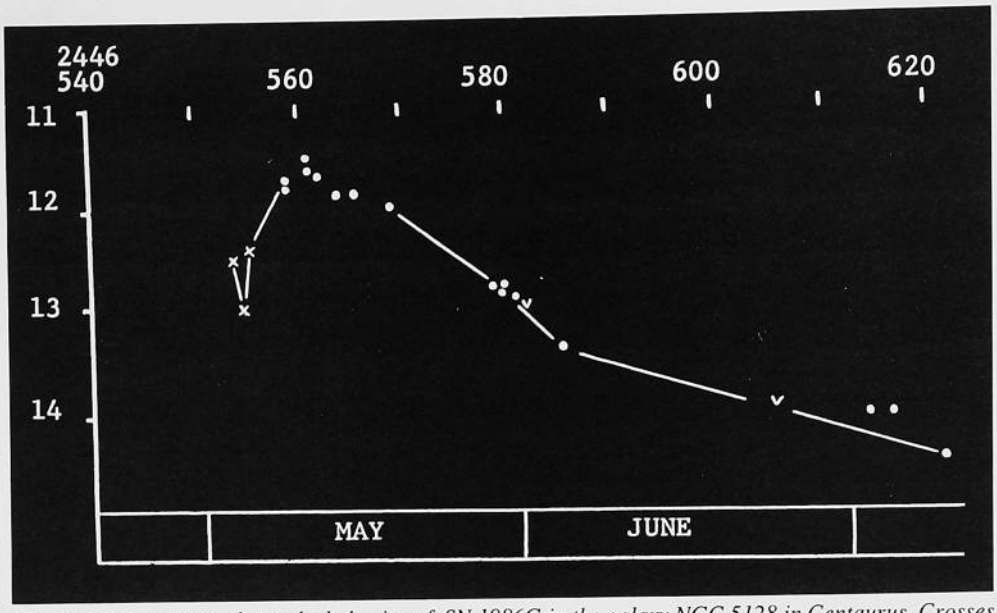
Discovering Stephenson 4-1

Dear Dave / As I began to delve into lesser-known planetary nebulae, I began a regular correspondence with California amateur Steve Gottlieb. One letter from Steve included a list of recently discovered planetary nebulae. As I checked the list I was impressed by the brightness of Stephenson 4-1 in Lyra, a magnitude -13.0 object discovered in 1985.

Since Lyra was high in the sky I decided to try observing the planetary. I hand plotted it onto *Uranometria 2000.0* since it was discovered too recently to be included. Steve provided equinox 2000.0 coordinates of 19h00.5m, +38°21'. I found the bright object easily and I had Steve confirm the observation to make sure I had the right object.

Stephenson 4-1 was discovered by C. B. Stephenson, who published information on his newfound object in the October 1985 issue of the *Publications* of the Astronomical Society of the Pacific. An observation I made showed the object as a stellar planetary visible with averted vision at medium power (96x). The object responds well to blinking with an O III filter. It sits next to a magnitude -11.5 star about 2' to the north. The two bright stars to the northwest in my drawing, just left of the line marking 19h0m right ascension, are plotted in *Uranometria 2000.0*.

Gordon Bond
313 Raphael Avenue
Middlesex, NJ 08846



This visual light curve shows the behavior of SN 1986G in the galaxy NGC 5128 in Centaurus. Crosses denote the discovery observation and early estimates by Rob McNaught while dots represent individual estimates by William Goltz and Peter Williams.

The Master of Supernovae

Dear Dave / Bob Evans' discovery of a bright supernova in M66 certainly caused a great deal of interest, as indicated by readers' letters in *Deep Sky* #27. The number of observers who wish to search for supernovae is certainly on the rise.

The secrets to Bob's success should not be underrated as he has certainly become a master of his art. Reverend Evans' persistence over many years, the copious number of galaxies checked on a regular basis, and an apparently unfailing photographic memory that faithfully recalls the appearances of the galaxies surveyed have all contribute to his astounding success.

This is supported by an efficient confirmation team consisting of Rob McNaught and Tom Cragg at the Anglo Australian Observatory and Gregg Thompson and Peter Anderson of Brisbane. Gregg's excellent series of supernova finder charts provides details of a galaxy's inner regions that often appear overexposed on photographs.

Although few supernovae rise to brighter than 12th magnitude, with reliable charts amateurs can make valuable follow-up magnitude estimates with telescopes as small as 6-inches in aperture. Observers with 16-inch scopes should be able to construct light curves down to about 15th or 16th magnitude. Such observations can add an exciting new dimension for those of us who enjoy viewing galaxies.

The enclosed light curve shows the brightness of supernova 1986G, an Evans discovery in NGC 5128 in Centaurus. The chart is based on estimates by only two observers, William Goltz and myself, and is typical of what amateurs can achieve.

Peter Williams
3 McAuley Close
Heathcote 2233 Australia

SUNSEARCH
Program Expands

Dear Dave / The challenge of observing the evening skies in search of supernovae need not be restricted to the large telescope owner. The SUNSEARCH program is encouraging the participation of small telescope observers and is currently accepting them for membership in the program. Those who are interested in using 6- to 8-inch scopes for supernova searching should contact either Jay Albert (17 Jeffrey Lane, East Windsor, NJ 08520) or Jenny Worsnopp (162 East 7th Street, New York, NY 10009) for more information.

The detection of these enormous stellar events represents one of the final bastions of scientific discovery left for the amateur. Careful scrutiny is the price that has to be paid in such a project. If you're willing to be a part of such an undertaking, please contact us at once.

Stephenson 4-1 sketched by Gordon Bond (10.1-inch Dobsonian at 96x).

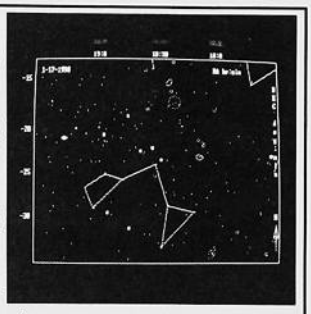
Steve Lucas
14400 Kolin Avenue
Midlothian, IL 60445

Correction

The Arizona Database is in no way associated with the Saguaro Astronomy Club Database. The sources of information used and the individuals involved in the construction of the Arizona Database are in no way connected with the sources of information or the individuals involved with the Saguaro Astronomy Club Database.

The Arizona Database (release 5.0) currently has 16,345 entries, including all NGC and IC objects. Copies may be obtained by sending a SASE floppy disk mailer with $.75 postage and two 360K floppy disks to Bob Erdmann, The Arizona Database Project, 971 East Driftwood Drive, Tempe, AZ 85283.

NIGHTSKY



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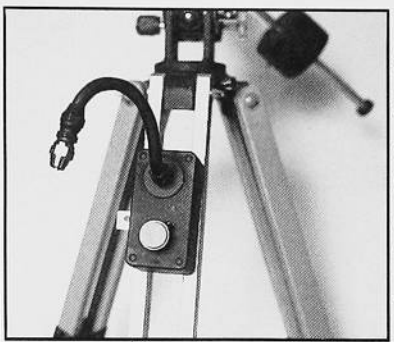

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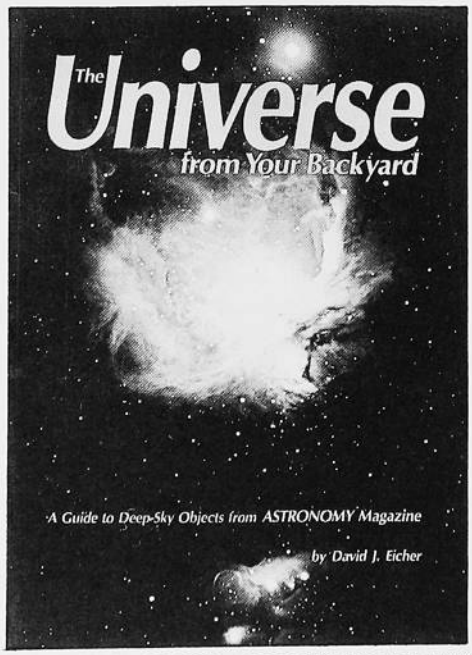

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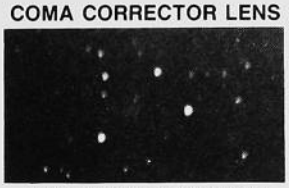

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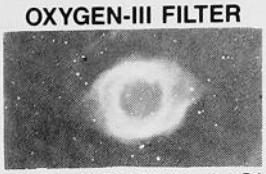

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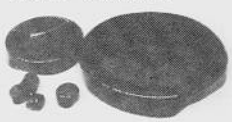

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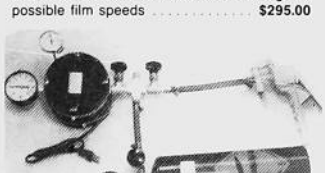

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Konica SR400, fine gr. color neg	12	$10.95
3M 1000, fastest slide film	20	$12.95
Fujichrome RD100, fine gr. slide	24	$12.95
5072, color slides from negs	36	$6.95
D-19 B&W Developer	1 gal.	$6.95

Prime Focus Astrophotography with a Newtonian

by Chris Schur

Prime focus astrophotography has never before offered backyard astronomers so much. Sophisticated, capable Newtonian reflectors are easily available along with precision astrophotographic accessories that make capturing starlight on film more fun than it's ever been. Simplified darkroom chemistries, gas hypering, and new high-resolution films have raised the potential to show remarkable details in amateur photographs.

With their short focal ratios and ease of use, Newtonian reflectors are the best telescopes for prime focus work. However, to perform properly a Newtonian must meet several basic requirements. Its base must be rock solid, have a firm footing on the ground, and neither bend nor flex. The telescope's mounting must move easily, and the drive must track smoothly. The mount should be free of play or wobble and be able to carry the tube without strain. The telescope's tube must be rigid and well sealed against the elements. Finally, the telescope's optics should be held securely, permitting no shifting of internal components as the tube moves through its two axes.

If you have such a telescope, can you use it for astrophotography? One of your primary considerations should be portability. Unless you have a dark sky in your backyard or an observatory out in the country, you'll have to transport the telescope each time you use it. This alone can be exhausting. The best compromise is to get a telescope that is not overwhelmingly large and partially dismantle it each time you transport it. You might even consider cutting the tube into two sections that can be reassembled with guide pins and latches. Carrying four to six pieces rather than one giant assembly will save wear and tear on your muscles.

Once you have your scope reassembled at the observing site, you may discover that brisk winds have a devastating effect on large tubes. Because the tube acts like a sail, you may see images of stars doing figure-eights in the eyepiece. Large scopes equipped for astrophotography must be absolutely solid. This may mean beefing up the tube or the thrust surfaces in the mount.

To determine how well your mount will do for astrophotography, give it the "thump test." Insert a medium-power eyepiece in the scope and center a star in the field. Thump the telescope with your thumb. If the shaking that results stops in five seconds or less, the telescope is suitable for prime focus work. Otherwise, consider modifying it to increase stability.

Large modern reflectors bring many advantages to astrophotography: huge light grasp; large, distinct images of faint objects; and relatively short exposure times. However, most large mirrors have very short focal ratios that do not provide crisp images over an entire field. To improve this stop down your telescope to somewhere between f/5 and f/6. This will yield sharp images to the edge of the frame.

Collimation is another critical factor. At f/5 the sharp field is equal to the size of a 35mm frame, so if your collimation job

The author's 16-inch f/4.5 Newtonian sits disassembled and ready to fit inside a truck for transport. Note the split tube: this was necessary to fit the scope into the truck. Photo by Chris Schur.

The scope fits snugly inside the author's truck. Opposite page: Globular NGC 2419 photographed with thetelescope (hypered Tech Pan film, 30-minute exposure). Photos by Chris Schur.

NGC 2362, the brilliant cluster surrounding Tau Canis Majoris, gleams in a 14-inch f/5 photo (hypered Tech Pan, 30-minute exposure). Opposite page: The Horsehead Nebula is recorded well in a 60-minute exposure on hypered Tech Pan film. Photos by Chris Schur.

is imperfect, you will see blurry stars on your negatives. Once you set up the telescope and its accessories, be prepared to spend the necessary time to collimate your scope carefully. The extra few minutes you spend doing a first class job will pay off many times over in the final results.

Another optical worry is the potential for focal shift during an exposure. In typical exposures of 30 to 60 minutes, the outside temperature can drop five or ten degrees. The long tubes of Newtonians can change in length due to thermal contraction. This may be enough to shift the focus out of acceptable limits.

The best tube materials have a low coefficient of thermal expansion. Wood or plywood laminates are best, followed by stainless steel, plastic or fiberglas, and aluminum. The best material to use will have a low thermal-expansion coefficient. Tubes should be well sealed and protected from moisture, as a damp night can also affect a tube's dimensional stability.

One of the greatest concerns with a large Newtonian is guiding. Guiding methods with a large scope are more demanding than with smaller instruments. The lightweight tubes found on these bulky portable instruments are not usually suitable for mounting a separate guidescope. Flexure causes trailed star images on negatives. For this reason I recommend an off-axis guider.

Individual off-axis guiders have their own advantages and disadvantages. The Lumicon Easy Guider uses a small prism at the edge of the field of view to divert a small portion of the incoming light into a guiding eyepiece. Two shortcomings of this device are rather poor guidestar selection and severe coma on bright guide stars lying near the edge of the field. Despite this, it is the best commercially available off-axis guiding system.

The Arizona On/Off axis system, a model developed by a group of amateurs near Phoenix, requires the installation of a tiny adjustable mirror in the center of the main diagonal. This facilitates using a small annulus of light around the shadow of the secondary for selecting guidestars. Light from the guide star is diverted to a 1.25-inch focuser on the outside of the tube. This second focuser is set at an angle next to the primary focuser. By tilting the small mirror with thumbscrews one can select guide stars within a 1.5° field surrounding the target object. The relatively long focal ratio of this system (about f/10) allows guiding on perfectly round star images over most of the obtainable field.

Regardless of the tracking system you use, you must use a proper illuminated reticle eyepiece. I have found that a 12mm ocular with a red LED works best. A dim guidestar is still visible against a deep red reticle, permitting guiding on faint stars. Use this in combination with a 2x or 3x Barlow lens to achieve a magnification of at least five diameters per inch of focal length in your prime focus system. For example, if you stop down your 13.1-inch f/4.5 scope to f/5 to improve sharpness, your focal length is still 59 inches. A 12mm eyepiece and a 2.5x Barlow lens will yield a magnification of 312x. This is 5.3 power per inch, which is approximately the recommended guiding magnification.

Another important consideration is comfort. You cannot guide for very long if you stand or bend over the telescope. A 30-minute exposure seems like

The outer spiral arms of the galaxy M61 in Virgo show well in this 60-minute exposure made with the author's 14-inch f/5 Newtonian. Schur used hypered Tech Pan film for the photograph.

eternity if you are not comfortably seated. A tall bar stool or a seat with a height adjustment is ideal. If you're comfortably seated you can probably guide for an hour or more without too much difficulty.

You also must estimate the amount of tube travel during the exposure. This is not usually a problem with small scopes, but with a large Newtonian the eyepiece end of the tube can move several feet during a long exposure. You may reach a point where you will have to discontinue or interrupt the exposure so that you can move your seat out of the way!

Getting well-tracked negatives also depends on the attributes of your drive corrector. For example, if the errors in the drive gear are faster than the correction capability of your drive corrector, then an inadequately tracked exposure will result. Some drive correctors I've seen are so slow to react that they couldn't even keep up with the average periodic errors found in most Schmidt-Cassegrain telescopes! The point is, check the maximum errors present in your system and make certain your drive corrector can handle them. You may even have to replace your present model to achieve this or install a higher quality gear on the scope.

Even the best drives, however, have occasional glitches. Wind gusts come up or airplanes fly through the area (usually right in front of your subject). I've installed an internal shutter mechanism on my telescopes to interrupt the exposure for short periods when needed. The idea is to only allow the shutter to be open when the guidestar is exactly on the negative that shows detectable guiding errors. The improvement in the quality of my photos with this system was dramatic. I used to consider a success rate of 50 percent pretty good. Now that rate is over 90 percent.

The Arizona On/Off axis system offers the advantage of keeping the guide star in the second focuser when the light is blocked from the camera. Because of this I can guide for fifteen minutes and then close the internal shutter. At this point I take a ten-minute coffee break. After returning to the telescope I re-center the guide star and reopen the shutter to resume the exposure. After another fifteen minutes I repeat the procedure. In this fashion a series of 15-minute exposures is chained together to form a composite exposure of an hour or more. This technique of "chain guiding" was discovered when amateurs I know found that guiding in brief spurts resulted in better tracking than longer stretches.

Film choice is crucially important for successful prime focus work. For most applications hypersensitized Technical Pan 2415 film is unquestionably king. This film combines good speed and contrast, ultrafine grain, and superb red speed. This film will not disappoint you. For color photography hypered Konica SR 400 is the best choice. Although the contrast is much lower than with Tech Pan, Konica has favorable color response over a wide spectral range including the H-alpha line. Konica's fine grain and good speed make it a fine choice to produce colorful, high resolution astrophotos of bright deep-sky objects. As for color slides, hypering is not a practical option because of the severe color balance shift in the background. Straight Agfa 1000 slide film works quite well and produces rich colors on a variety of deep-sky objects.

Tom Dessert's photo of the core of the Virgo Cluster was made with a 10-inch f/5 Newtonian. Dessert employed 103a-F film for the 20-minute exposure.

Once you have your telescope up and running and your camera loaded with film the fun can begin. Accurate polar alignment is essential. Although many astrophotographers rely on the old standby of using the drift method, I've found that a great deal of time can be saved by sighting on the pole directly. I use a V block arrangement and a small finder scope that is parallel to the main polar shaft. I then determine the exact position of the pole relative to Polaris or Sigma Octantis and aim the finder sight on the V block exactly at that position. Polar alignment accurate to a tenth of a degree is possible in this manner. This is adequate for most operations.

Next, you center the subject in a wide-field eyepiece. I've found that a 32mm Erfle with a 2-inch barrel size has the same field as a 35mm frame. This allows me to precisely compose the field. The next step is to find a suitable guide star. Take a good look at the guiding field in a low-power ocular and then install the camera onto the primary focuser. Pan the scope over to a 2nd- or 3rd-magnitude star for focusing. Focusing is critical in short focus instruments. The steep light cone produced by a fast mirror makes it difficult to be certain where precise focus is.

Rather than removing the film for a knife-edge check or investing in expensive focusing aids, I use a 6x finder scope to achieve perfect focus. The idea is to set up the camera in the daytime and peer into the viewfinder with the finder scope. Adjust the finder's focus such that the ground glass in your camera's viewfinder is in sharp focus. (You may have to install a weak positive lens in front of the finder's objective because most 35mm viewfinders are set for a focus of about six feet.) Use the modified finder scope to focus your camera on the star. The six-power focusing advantage assures you of sharp focus every time.

Pan back to the main subject and recenter the guide star in the low-power ocular. By doing this you'll know that your exact composition is now in the camera even if you can't see the dim nebula in the viewfinder. After installing a Barlow lens and reticle eyepiece for guiding start the exposure by opening the camera's shutter and then the focal plane shutter.

If all goes well you will end up with half a dozen shots in a single evening. Once the film is developed return the unused portion to the freezer to retain its sensitivity. For color film select the best frames and package them in clear negative sleeves for commercial printing at the local one-hour photo lab. For black-and-white emulsions I suggest making your own prints in a home darkroom.

As you review your prints you'll see that additional objects were recorded besides the primary subject. With a large Newtonian reflector you'll be able to record objects much fainter than you can see.

Prime focus astrophotography is considerably more complex than it was just a few years back. We are driven by new film technologies along with a unique blend of perseverance and a quest for excellence. This enables backyard astrophotographers to produce results that in the past were accomplished exclusively by professionals.

Chris Schur is an avid astrophotographer living in Black Canyon City, Arizona.

Exploring the Region of M51

by Robert Bunge

On June 8, 1907, French observer Guillaume Bigourdan recorded his last observation of M51 for his visual survey of Dreyer's *New General Catalogue (NGC)*, which Bigourdan titled *Nebuleuses et D'Amas Stellaires*.

Bigourdan had set out to observe all of the NGC objects using a 12-inch refractor at the Paris Observatory. Bigourdan recorded M51, the famous Whirlpool Galaxy in Canes Venatici, as a brilliant, 50"-diameter nebula with an even more brilliant central region. Apparently Bigourdan did not see the galaxy's spiral arms. His summary was drawn from observing M51 four times during the course of the survey. Unlike most observers of his day, Bigourdan looked at more than just M51 and its companion, NGC 5195. He observed at least five other NGC galaxies in the region around M51. Bigourdan looked at the NGC objects and didn't do a detailed search for any other nearby galaxies. If he had done so he might have noticed several other galaxies in the region.

Over the past century things haven't changed much. Today amateurs by the thousands enjoy viewing M51 but rarely, do they bother to find the dozen or so fainter galaxies within a two or three degree circle around the Whirlpool galaxy. Many of these galaxies are visible with modest backyard telescopes.

Before you attempt to observe these galaxies, however, do take a look at M51. In the 31-inch F/7 Newtonian telescope at Warren Rupp Observatory the spiral arms of M51 can be seen with ease by visitors who have never looked through a telescope before. To the trained eye the Whirlpool breaks down into a wealth of detail that is almost impossible to draw on paper. Knots and twists in the arms burst through the glow of the galaxy's disk of stars that spread out to form what appears to be the faint bridge that connects the large galaxy NGC 5194 with its small companion NGC 5195.

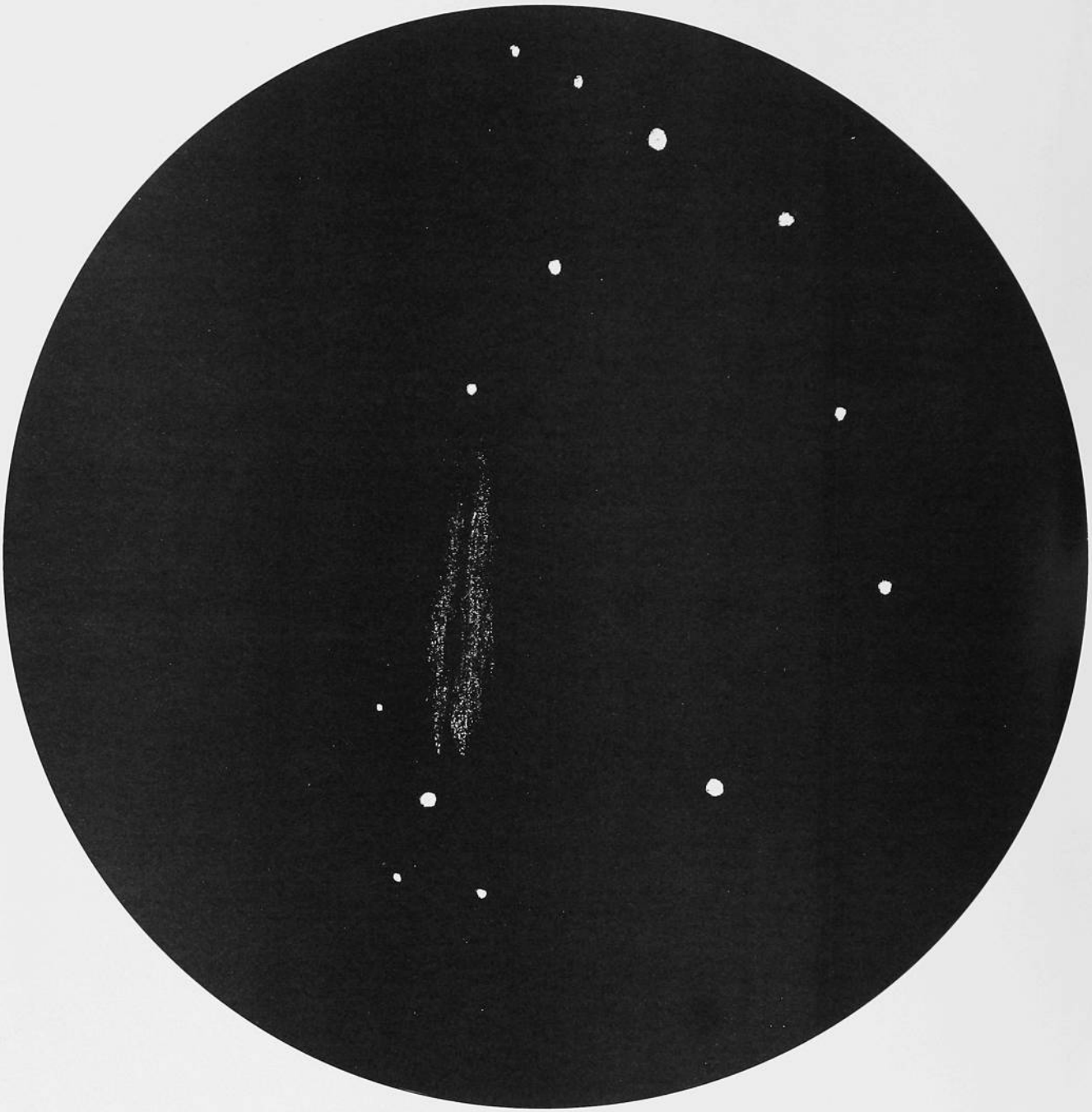
My interest in hunting the galaxies near M51 was inspired by seeing the faint edge-on galaxy that appears in many long-exposure photographs of M51 (on the cover of volume one of *Burnham's Celestial Handbook*, for example) just to the northeast side of NGC 5194. Despite trying repeatedly to see it repeatedly with the 31-inch scope, it remained invisible.

I discovered the galaxy's designation is **IC 4277** and found that it receives only a listing in *NGC 2000.0* — no magnitude or description. IC 4277 and nearby **IC 4278** were both discovered by American astronomer James Edward Keeler on photographs of M51 that he took using the 36-inch Crossley reflector at Lick Observatory.

After an unsuccessful try at IC 4277 I decided to try to find some of the NGC objects plotted on chart 76 of *Uranometria 2000.0*. Moving from IC 4277 almost directly south, just less than a degree, I found **NGC 5198**. At 200x this galaxy showed little detail other than its shape and a stellar core. Its magnitude is approximately 12 and the galaxy's longest dimension is 2.1'. John Herschel was the source of Dreyer's visual

NGC 5169 (top), NGC 5173 (middle) and MCG +08-25-006 sketched with a 31-inch f/7 reflector at 200x. All sketches in this article are by Robert Bunge.

NGC 5198 sketched with the 31-inch f/7 scope at 200x. Opposite page: M51 photographed by Ron Potter with a 14-inch f/11 SCT, hypered Tech Pan, and a 120-minute exposure.



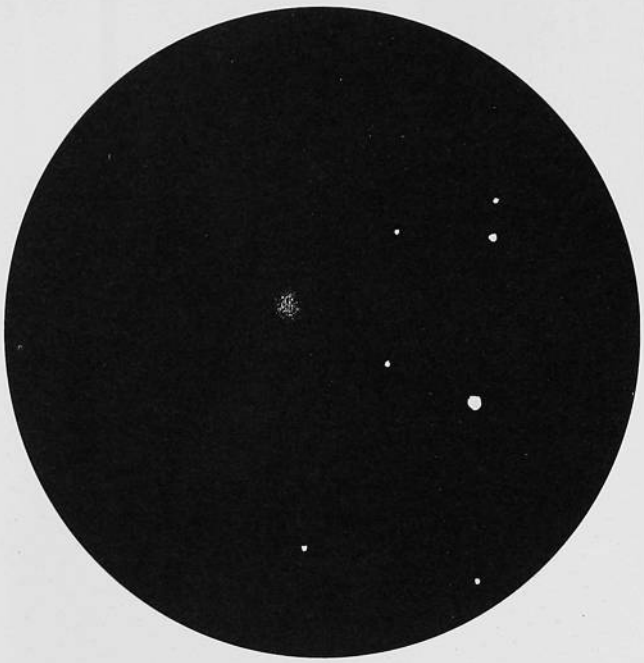
NGC 5229 sketched with the 31-inch f/7 telescope at 200x.

description, which called this object "pretty faint, pretty small, round and much brighter in the middle." When he observed it in 1897 and 1907 with the 12-inch refractor, Bigourdan thought NGC 5198 was round, notably brighter toward the center, and about 40" in diameter.

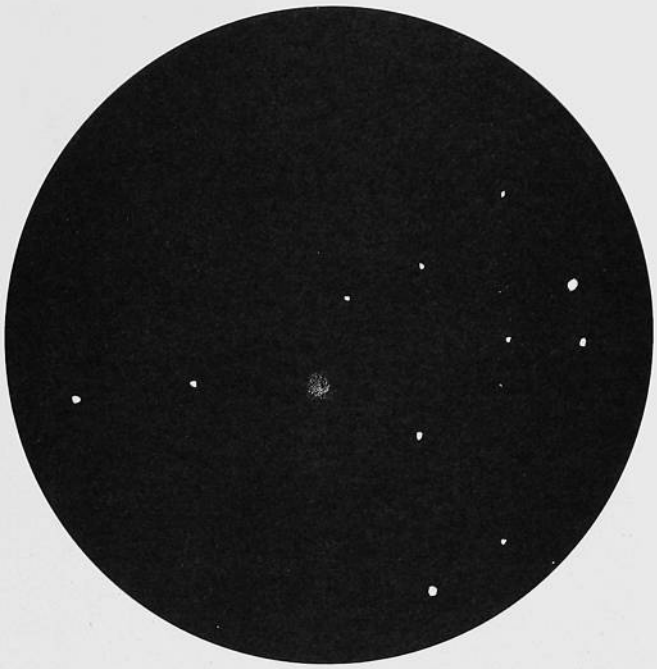
About two arcminutes west are **NGC 5169** and **NGC 5173**. At 200x both of these galaxies lie within the same field. NGC 5169, the northernmost of this pair, was a fine sight with averted vision. This galaxy appeared as a large, faint oval with a brighter central region that did not show any sort of stellar core. Some distance to the south-southeast lies an anonymous galaxy that is not plotted on *Uranometria 2000.0* or listed in the NGC or IC catalogs.

The *Revised New General Catalogue (RNGC)* lists NGC 5169 as having a photographic magnitude of 14.5, while the more precise *Uppsala General Catalogue (UGC)* offers a photographic magnitude of 13.6. *NGC 2000.0* splits the difference at photographic magnitude 14. In any case, small backyard telescopes under good conditions show this galaxy. Bigourdan saw it with the 12-inch refractor and described it as being about 25" or 35" across with a bright center surrounded by a trace of faint nebulosity. Dreyer described NGC 5173 as very faint, pretty small, and round. Bigourdan thought it was "round, with a very feeble surrounding nebula and about 20" to 30" in diameter." The 31-inch at 200x easily showed Bigourdan's surrounding glow and a bright nucleus with averted vision.

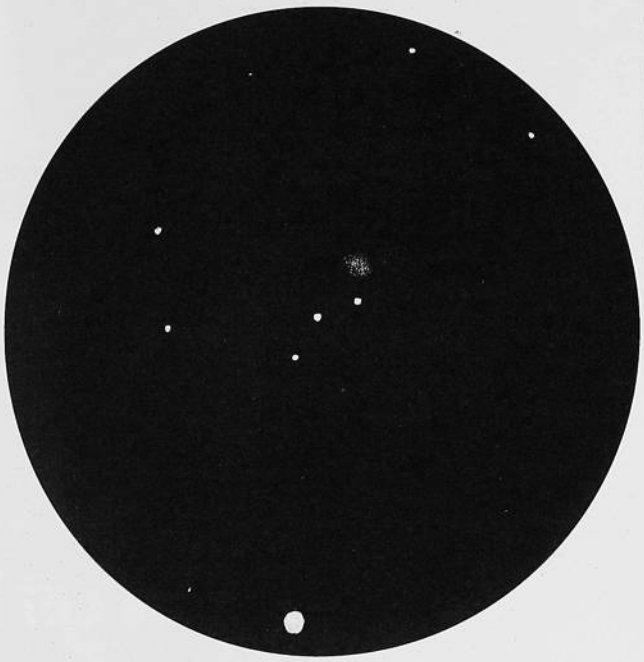
The anonymous galaxy at the southern edge of the field of view later proved to be **MCG +08-25-006**. Of all the major



UGC 8588 sketched with the 31-inch f/7 scope at 200x.



UGC 8538 sketched with the 31-inch f/7 reflector at 200x.



MCG +08-25-010 sketched with the 31-inch f/7 scope at 200x.

MCG +08-25-017 sketched with the 31-inch f/7 scope at 200x.

sources, only Vorontsov-Velaminov's *Morphological Catalogue of Galaxies (MCG)* listed this galaxy. It was easy to see in the 31-inch scope as a faint, north-south elongated nebulosity. I could not see any other detail.

To finish off most of the nearby NGC galaxies I moved the telescope slightly northeast of M51 to **NGC 5229**. After centering the location of the galaxy in the finder scope, I looked in the eyepiece of the 31-inch scope and was greeted by the sight of a large, beautiful edge-on galaxy with a broad equatorial dark lane. NGC 5229 is one of about 900 objects discovered by American astronomer Lewis Swift with the 16-inch Clark refractor at Warner Observatory in New York. Known for his many comet discoveries, Swift also searched for nebulae. Based on Swift's description, Dreyer listed NGC 5229 as "extremely faint, large, much extended and very difficult." The galaxy shows no hint of a nucleus or other brightening toward its center in the 31-inch. In 1901 Bigourdan described NGC 5229 as a large, diffuse nebula measuring 1' in diameter. The UGC lists NGC 5229 as an edge-on SBc system with a photographic magnitude of 14.5. The RNGC description reads: "Edge on, little brighter towards the middle, very flat, with an equatorial dark lane."

In the course of looking at these galaxies I had seen several other objects not plotted on *Uranometria 2000.0* in the area around NGC 5198 and the NGC 5169/NGC 5173 pair. The next step was to examine in detail a copy of the POSS chart of the region to see what else I might be able to observe in the area around M51.

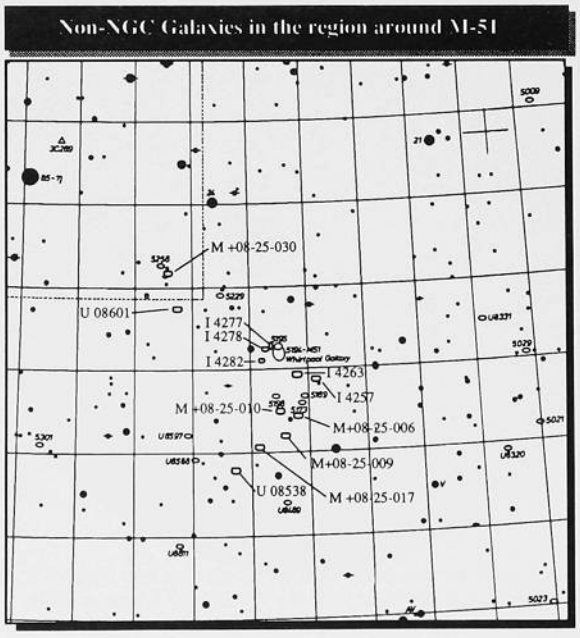
Just south and slightly east of NGC 5198 I found **MCG +08-**

List of Galaxies near M-51

Object Name	Ra (2000)	Dec	Mag.[P]	
UGC 08320 (ZWG 245.036) (MCG+08-24-093)	13 14.4	+45 55	14.0 (Z)	N/O
UGC 08331 (ZWG 245.038) (MCG+08-24-097)	13 15.5	+47 29	15.6 (Z)	N/O
IC 4257	13 27.3	+46 52	N/A	
NGC 5169 (UGC 08485) (ZWG 246.002) (MCG+08-25-004)	13 28.2	+46 40	13.6 (Z)	
NGC 5173 (UGC 08468) (ZWG 246.003) (MCG+08-25-005)	13 28.4	+46 36	13.5 (Z)	
MCG+08-25-006	13 28.6	+46 30	16.0 (M)	
IC 4263 (UGC 08470) (ZWG 246.004) (MCG+08-25-007)	13 28.6	+46 56	15.4 (Z)	
MCG+08-25-009 (ZWG 246.005)	13 28.8	+46 15	15.1 (Z)	
MCG+08-25-010 (ZWG 246.006)	13 29.2	+46 31	15.7 (Z)	
UGC 08499 (ZWG 246.007) (MCG+08-25-011)	13 29.7	+45 24	15.2 (Z)	N/O
NGC 5198 (UGC 08499) (ZWG 246.010) (MCG+08-25-015)	13 30.2	+46 40	13.2 (Z)	
IC 4277	13 30.3	+47 19	N/A	UN
IC 4278	13 30.4	+47 15	N/A	UN
IC 4282	13 31.3	+47 11	N/A	N/O
MCG+08-25-017 (ZWG 246.011)	13 31.6	+46 10	15.0 (Z)	
UGC 08538	13 33.2	+45 52	17.0 (U)	
NGC 5229 (UGC 08550) (ZWG 246.013)	13 34.1	+47 55	14.6 (Z)	
UGC 08588 (ZWG 246.016) (MCG+08-25-023)	13 35.8	+45 56	15.1 (Z)	
UGC 08597 (ZWG 246.018) (MCG+08-25-025)	13 36.3	+46 13	15.2 (Z)	N/O
UGC 08601 (MCG+08-25-017)	13 36.5	+47 45	17.0 (U)	N/O
UGC 08611 (ZWG 246.020) (MCG+08-25-029)	13 36.9	+44 45	15.5 (Z)	N/O
MCG+08-25-030	13 37.7	+48 14	16.0 (M)	N/O
NGC 5256 (UGC 08632) (ZWG 246.021)	13 38.3	+48 17	14.1 (Z)	

I have tried to cross reference names of objects whenever possible. Positions attained from sources in the following order: NGC2000, Zwicky, UGC, MCG. Photographic magnitudes attained from sources in the following order: Zwicky, UGC, MCG. N/O in last column means Bunge did not try to observe object. UN means unsuccessful observation.

Chart by Robert Bunge



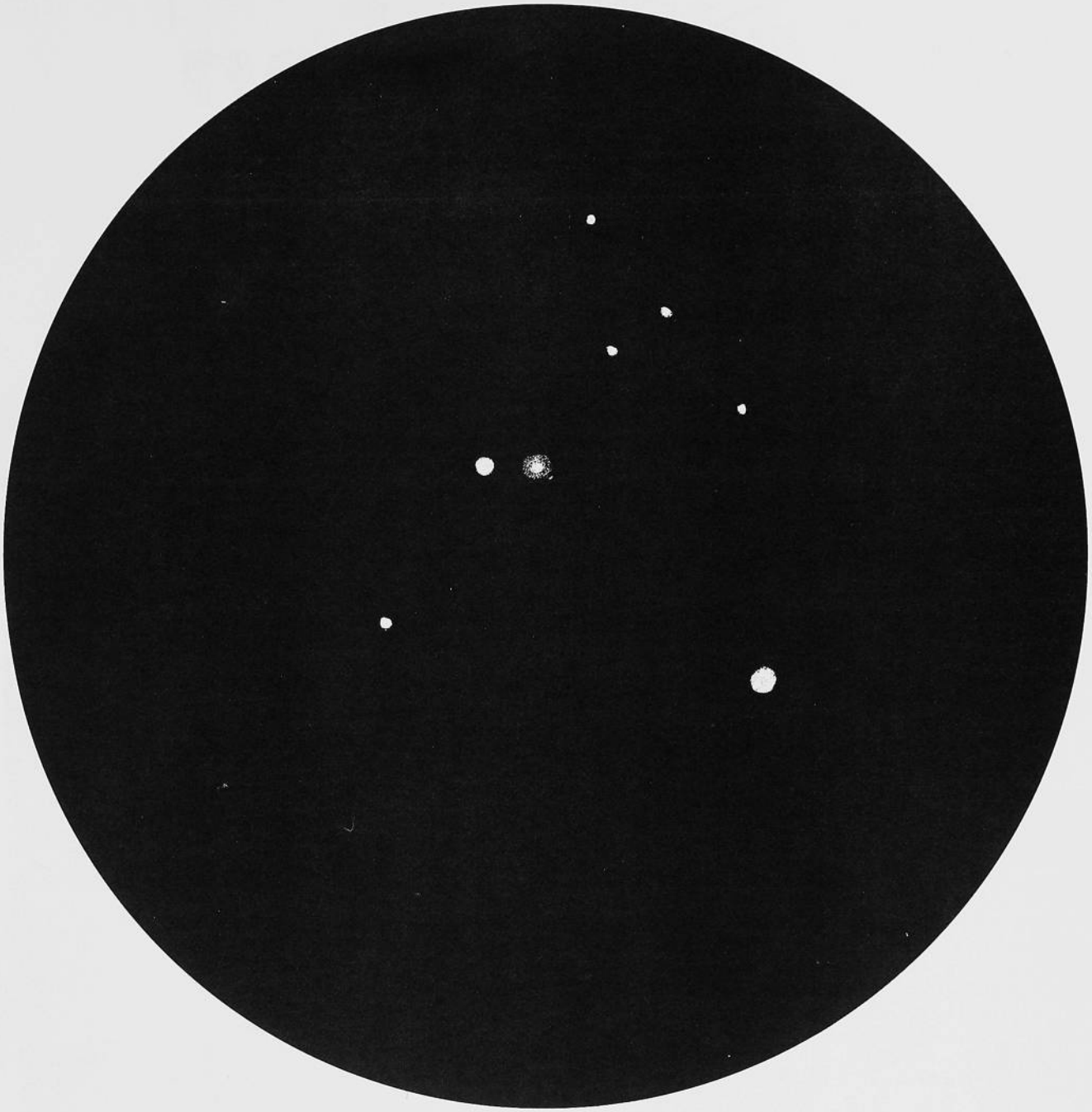
MCG +08-25-009 sketched with the 31-inch f/7 scope at 200x.

25-010, also the fifth galaxy listed in region 246 of Fritz Zwicky's *Catalogue of Galaxies and Clusters of Galaxies (CGCG)*. The CGCG lists the galaxy as having a photographic magnitude of 15.7, while the MCG provides dimensions of 6" by 5" and an inner core with a diameter of 1.5" across. I observed the galaxy in the 31-inch at 200x as a round, featureless, even glow that was very difficult to see and was visible only with averted vision.

South and east of M51 lie two more IC objects that were photographically discovered by Keeler with the Crossley reflector. The easternmost is **IC 4263**. I found it to be a large, cigar-shaped object with no detail that was difficult to see even with averted vision. Dreyer affixed the following description to IC 4263: "extremely faint, pretty large, and much extended with a much brighter middle region." The *UGC* gives it a photographic magnitude of 15.4 with blue-light dimensions of 1.9' by 0.4' (p.a. 105°).

As a study in contrast, neighbor **IC 4257** was a very small, almost stellar point with only a little fuzziness in the 31-inch scope. Too small to be listed in the *UGC*, IC 4257 fails to make any of the modern catalogs. *NGC 2000.0* lists the galaxy but does give a magnitude. From the Keeler photographs Dreyer described it as extremely faint, small, round, and diffuse. Since I found it to be small but bright, I suggest you use high magnification and study each star in the plotted region with great care for faint nebulosity surrounding it.

South of NGC 5169 and NGC 5173 you may be able to find **MCG +08-25-009**. This galaxy was easy to see in the 31-inch scope. With a photographic magnitude of 15.1 this



IC 4257 sketched with the 31-inch f/7 scope at 200x.

object has an oval shape with a bright, direct-vision stellar core. Averted vision really made this galaxy look good, appearing like a bright nucleus with a faint outer shell. Continuing southeast we find **MCG +08-25-017**, an object with a photographic magnitude of 15. This galaxy was also easy in the 31-inch scope at 200x. I saw it with direct vision as a large, round patch with a slight brightening toward the center. The MCG lists it as having a 3' by 2.5' central region and a size of 6' by 7'.

Yet another bump south and east brings you to **UGC 8538**. I looked for this galaxy for some time before I finally noticed it with 340x. I confirmed the galaxy's presence by moving the telescope slightly and by taking a short break and coming back to it only to still see it. I wasn't surprised to see the object listed at photographic magnitude 17 in the *UGC*. One must remember that *UGC* magnitudes fainter than 15.7 were estimated from the *POSS* photos, so it may in actuality be brighter.

The last galaxy I observed was **UGC 8588**, which is plotted in *Uranometria 2000*. This galaxy has a photographic magnitude of 15.3 and was a real challenge to see in the 31-inch scope at 340x. I saw no detail, only a very small, round glow. The *UGC* lists this galaxy as a dwarf spiral system with a blue-plate diameter of 1.4' and an inclination of 1.0, meaning that it is face-on to our line of sight.

Next time you're under dark skies give these galaxies a try. The challenge of finding some faint objects will never be greater than with this group of small, faint galaxies that surround the old Whirlpool.

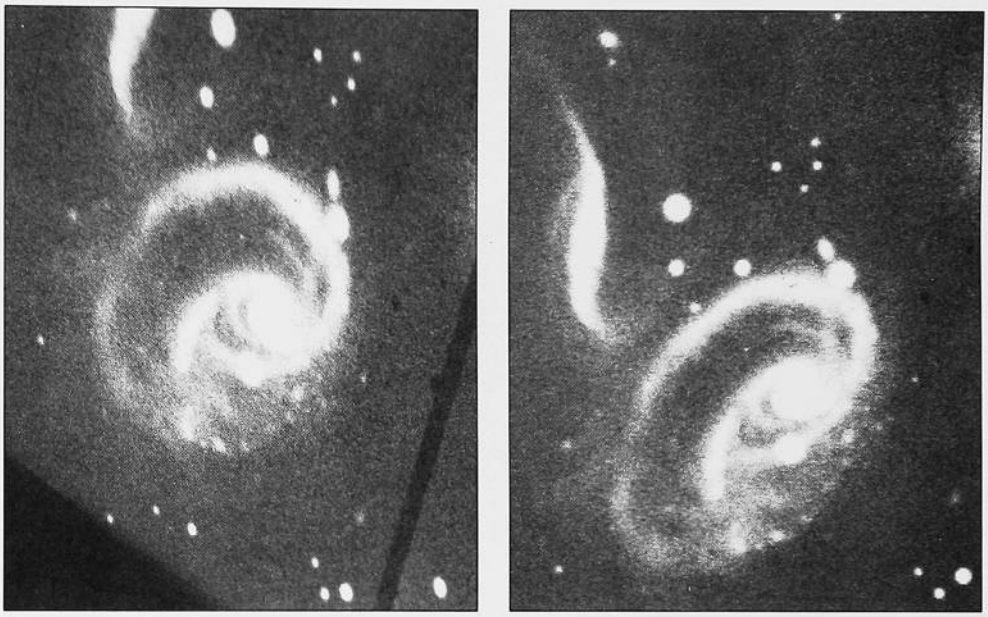
Robert Bunge is an a reporter at the Springfield News-Sun *in central Ohio.*

An Update on Galaxy Tilting

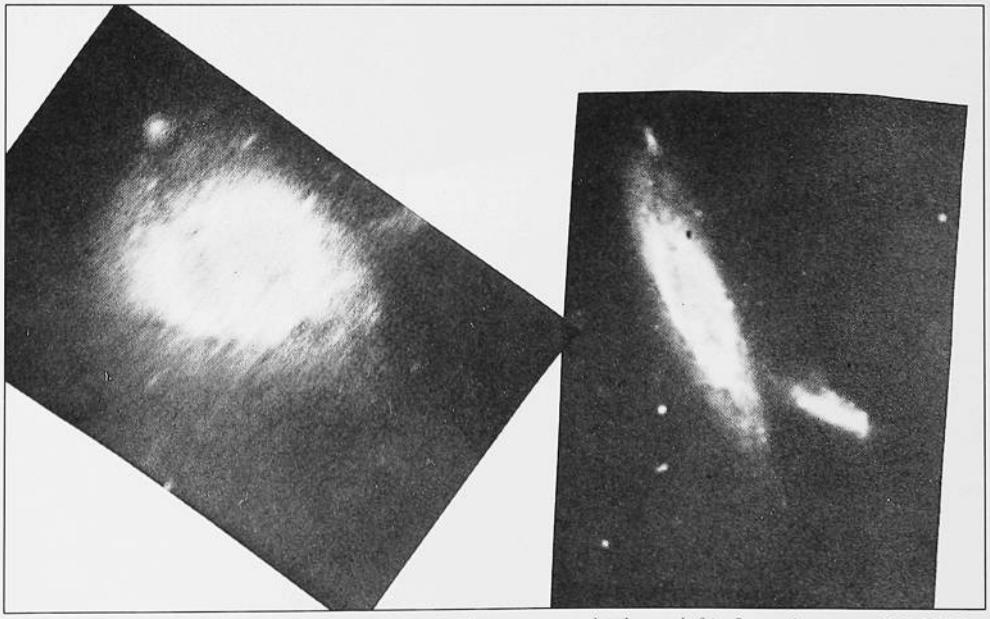
by Alan Goldstein

Spiral galaxies have a wide variety of structural forms. Face-on spiral galaxies have arms that are plain to see. Barred structures also show conspicuous structure. However, because most galaxies are inclined to our line of sight, structural features in galaxies are usually less than ideally viewed. Galaxies that are edge-on to our line of sight (inclination = 90°) show virtually no structural detail except for peripheral dust lanes.

"Correcting" spiral galaxies in the darkroom by tilting their images to simulate a face-on appearance provides astronomers with an improved view of what the galaxies look like. I described the photographic technique behind this process in *Deep Sky* #12 (Fall 1985). The purpose of this article is to illustrate some of my recent results with this technique. The sources of photographs used in this project are the Mount Wilson and Palomar Observatories, Kitt Peak National Observatory, and the *Atlas of Peculiar Galaxies* by Halton Arp.



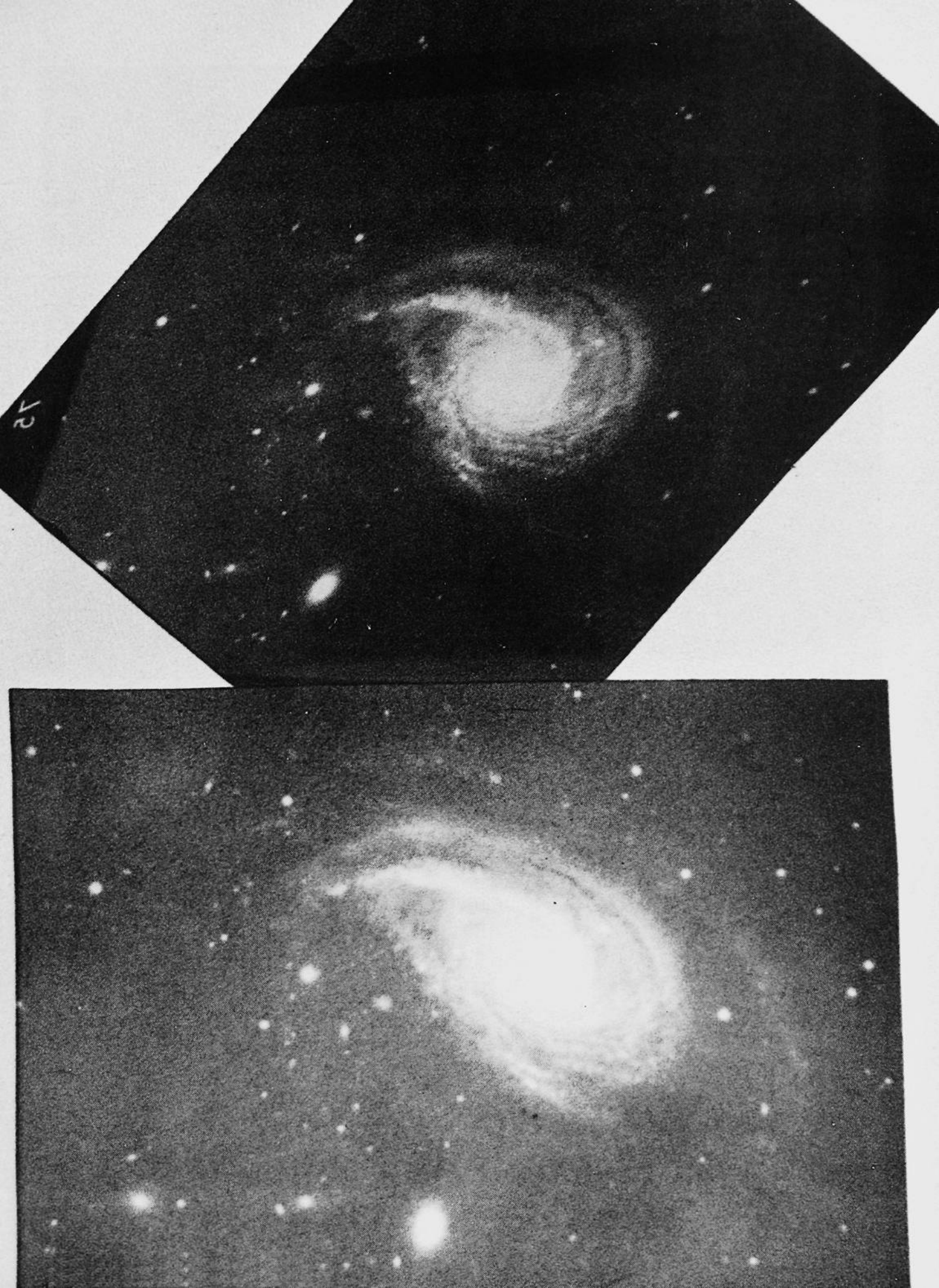
The unusual pair of galaxies Arp 273 is composed of Sc and SBb objects gravitationally distorting each other (left). The corrected view shows the largest galaxy as it would appear face-on. Photos adapted from Arp's Atlas of Peculiar Galaxies.

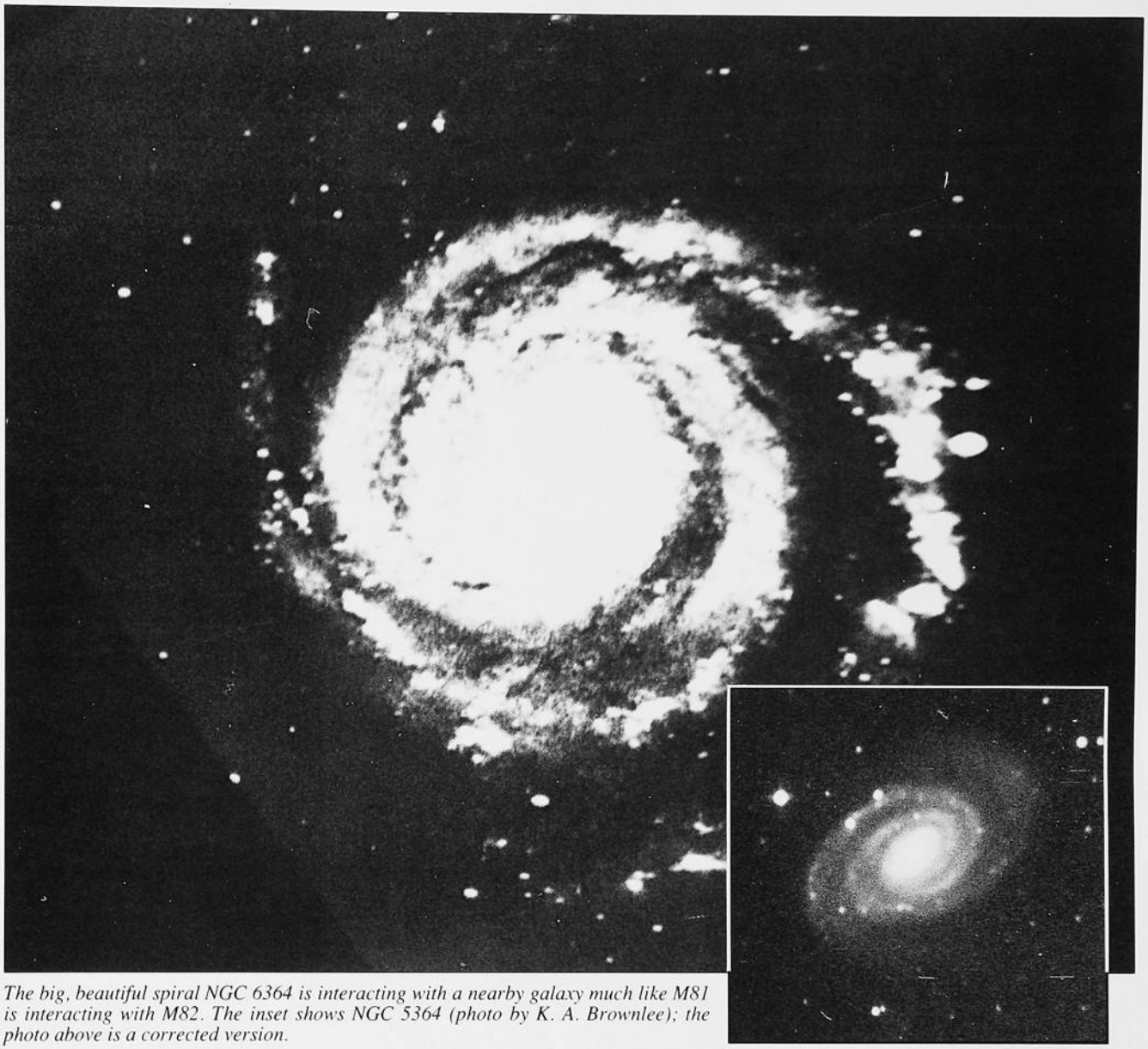


NGC 3769 shows a strong inner ring structure when corrected (above, left). Opposite page: NGC 772 has a peculiar arm structure due to an interaction with nearby NGC 700. Correcting it reveals a round, knotty core of tightly-wound arms (top).

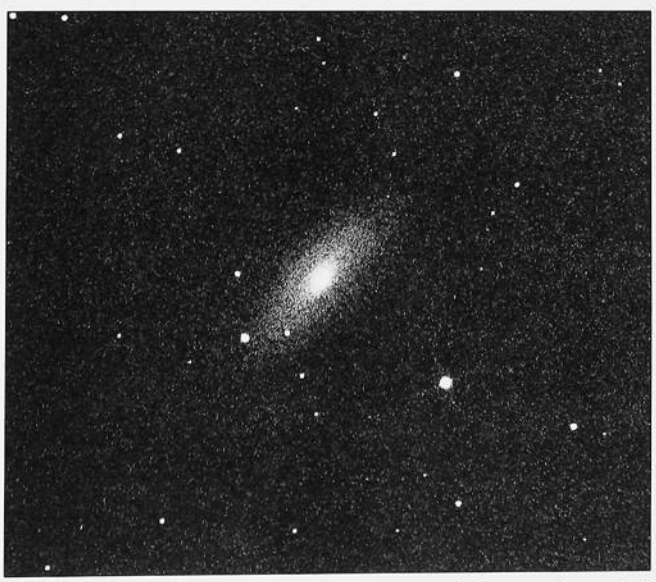
NGC 497 (Arp 8) is a transitional barred spiral S(B)c showing an inner ring structure with asymmetrical arm "spurs." It is inclined about 60° to our line of sight.

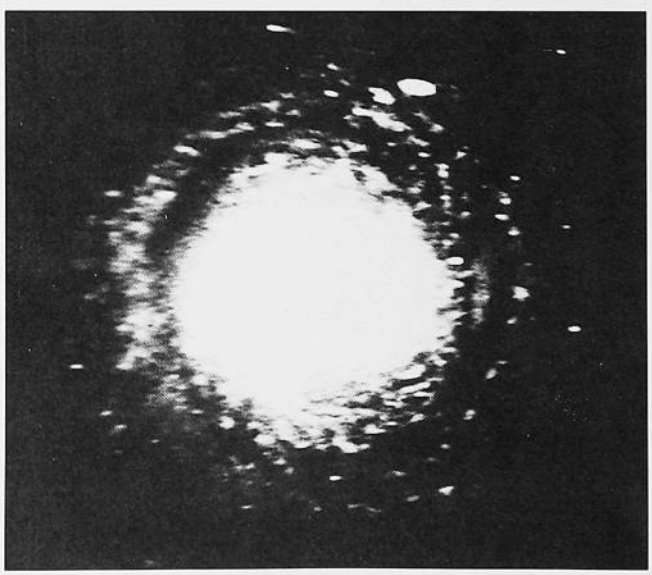
NGC 772 (Arp 78) is the biggest galaxy in Aries and shows a peculiar arm structure from a close physical encounter with NGC 770. Of particular interest are the twin arms on one side of the spiral and the "tangential arm" on the opposite side. It is inclined 55°.



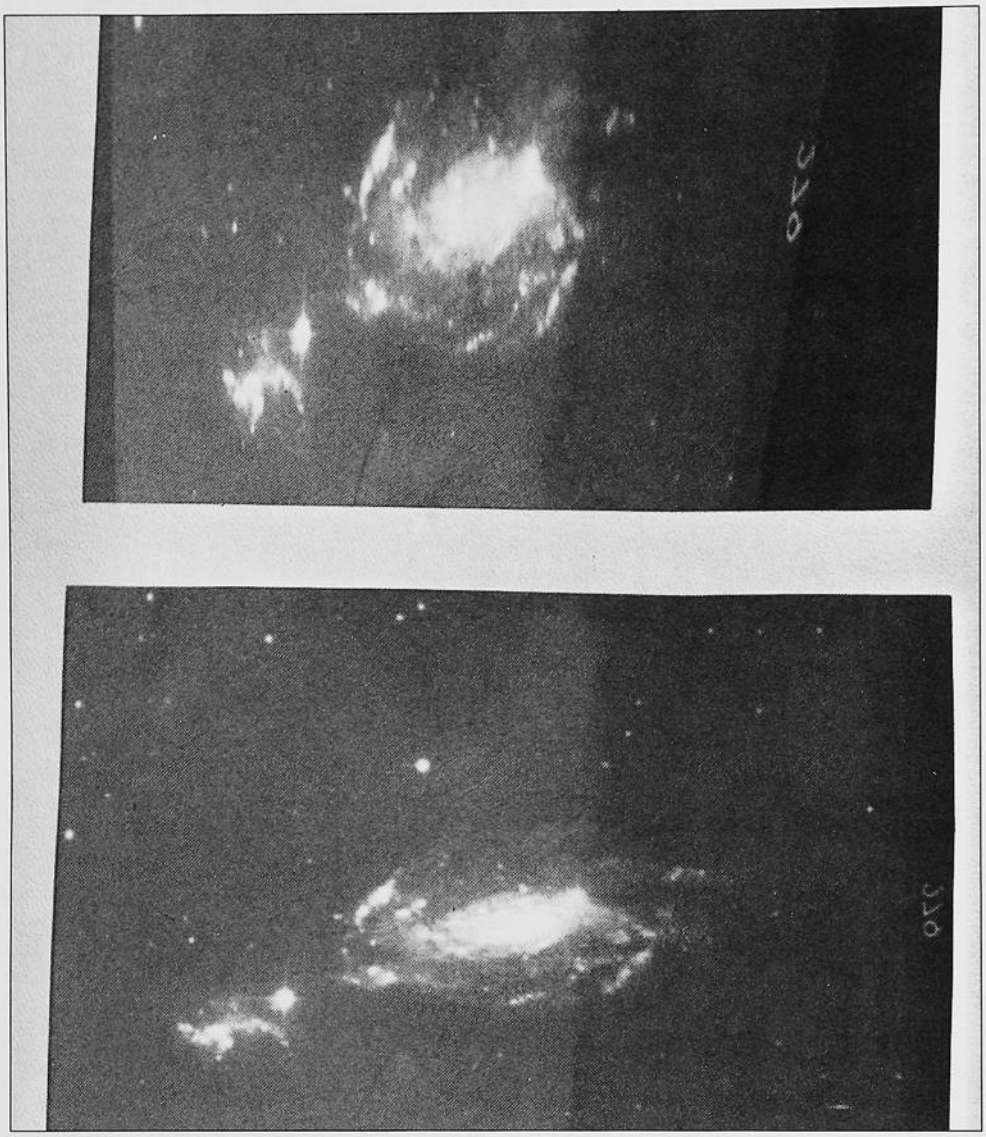


The big, beautiful spiral NGC 6364 is interacting with a nearby galaxy much like M81 is interacting with M82. The inset shows NGC 5364 (photo by K. A. Brownlee); the photo above is a corrected version.

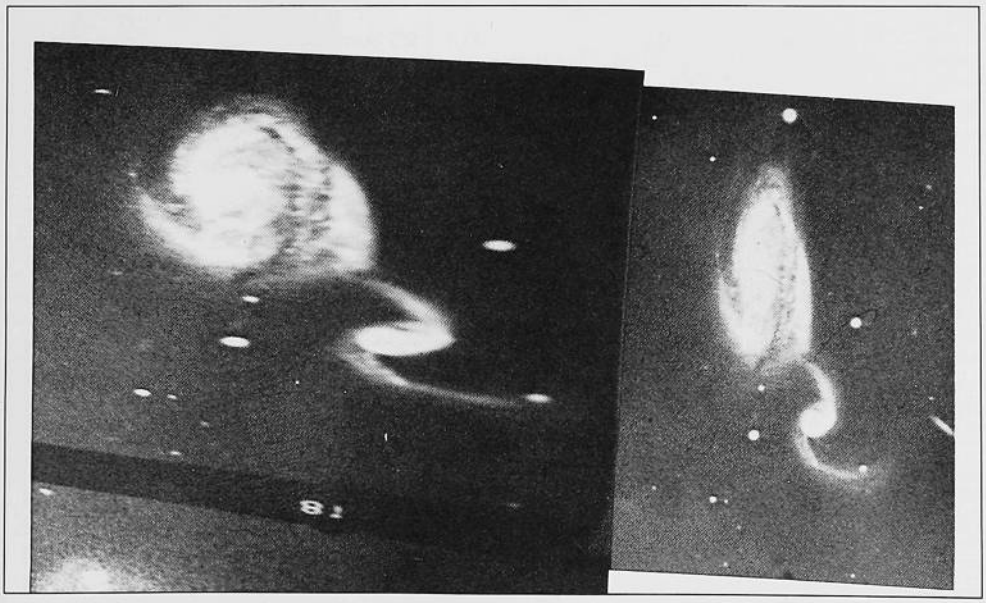




NGC 2841 is a tightly-wound spiral composed of many fine spiral arms. It is inclined 67° to our line of sight (left, photo by Preston S. Justis; 10-inch f/6 reflector, 103a-) film, 30-minute exposure). The galaxy takes on an entirely differencnt appearance when corrected (right).



NGC 1253 is a transitional barred spiral with a thick inner hub. Its arms show minor interactive distortion (above). Corrected, the galaxy's knotty arms are much better seen.



NGC 5394/5 is an interacting pair consisting of a massive Sb galaxy and a thin-armed Sc galaxy. Correcting for the Sc galaxy reveals its beautiful, symmetrical shape.

NGC 1253 (Arp 279) is another transitional barred spiral, S(B)cd. It sports a condensed inner hub with thin spiral arms. Arms show only minor distortion due to interaction with its anonymous Magellanic-type companion. It is inclined about 60°.

NGC 2633 (Arp 12) is a classic "S"-shaped barred spiral, an SBb. Correction results are particularly dramatic. Structurally, this galaxy shows large sinuous HII regions and an obscuring dark nebula surrounding its hub. It is inclined about 45°.

NGC 2841 is a tightly wound spiral, an Sb galaxy. Although it is inclined 67°, the rectified photograph shows a weak outer-disk ring formed by the merging of many arms.

NGC 3769 (Arp 280) is a highly inclined (about 85°) barred spiral having strong inner ring structure and a bar obscured by the inner disk. The outer disk shows only the weakest arm structure.

Arp 273 is composed of a pair of Sc and SBb galaxies undergoing gravitational interaction and distortion. The northern arm virtually wraps around the entire spiral. The southern arm is much shorter, bifurcated and appears to arch over the other arm twice. It is inclined about 60°.

NGC 5364 is an open spiral galaxy that is interacting with NGC 5363, a large elliptical galaxy about 15' away (much like M81 with M82). The most conspicuous feature is its asymmetrical arms.

NGC 5394/5 (Arp 84) is another interactive pair consisting of a massive Sb and a thin-armed Sc type galaxy. The rectified galaxy is the larger Sb. The actual shape of the smaller galaxy is probably warped in three dimensions, making interpretation difficult. Note the two strong arms in the Sb and the large lump of stars and gas between the two. Inclination of the Sb is about 65°.

Alan Goldstein is the founder of the National Deep Sky Observers Society, author of one of the chapters in Deep Sky Observing with Small Telescopes, *and a frequent contributor to* Deep Sky.

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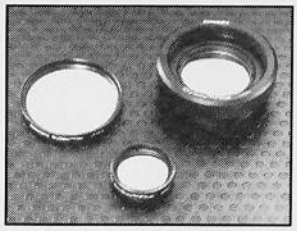

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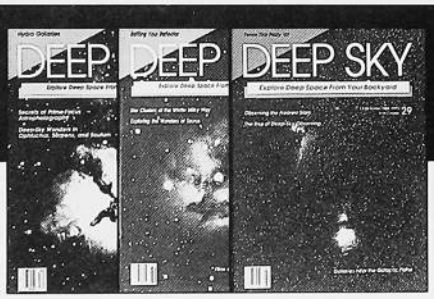

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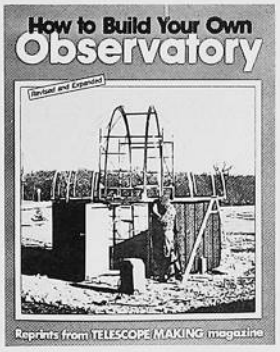

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Deep Sky Reports
Open Clusters of the Southern Cross
by Stephen Pattie

The brilliant constellation Crux lies smack dab in the middle of the southern Milky Way. Within the 9° by 7° dimensions of this group of stars lie many famous objects of the southern sky. One of Crux's three 1st-magnitude stars, Acrux (Alpha Crucis), is a magnificent close double star. Crux also contains the Coal Sack, a large dark nebula that blocks out the rich background Milky Way. Crux also contains many unusual open clusters that show how unique these objects are when viewed with small telescopes.

The most impressive cluster in Crux is **NGC 4755**, the famous Jewel Box, which lies between Beta Crucis and the Coal Sack. This cluster consists of seventy stars in a diameter of 8'. The six brightest stars range from 6th to 9th magnitude and form the shape of a letter A.

The central star of the Jewel Box is a lovely orange M-type star that contrasts nicely with the other stars, all of which are blue-white objects. The majority of the stars in NGC 4755 glow at about magnitude 10 and are offset to the southwest of the brightest members. With a 6-inch telescope at 80x, a wide, dark cross can be seen superposed on the 10th-magnitude stars. The dark feature is less noticeable as aperture increases because the faint stars become more prominent.

NGC 4609 is a small, loose cluster measuring just 5' across. NGC 4609 contains sixteen members between magnitudes 8 and 10; there appear to be about thirty members down to 11th magnitude. With a 17.5-inch scope at 118x the brightest stars appear shaped in a broken rectangular pattern. A magnitude 5.5 star lies 4' southeast of NGC 4609.

If you're looking for a large, low surface brightness cluster, try observing **H7**. With a 6-inch scope at low power this object appears as a faint haze with five or six stars resolved. At higher powers the 6-inch scope still can't resolve the cluster's fainter members. In a 17.5-inch telescope H7 appears very rich but is somewhat difficult to distinguish as a cluster due to the richness of the Milky Way background. H7 contains about 150 members ranging from 12th to 15th magnitude; the majority are fainter than 13th magnitude. I estimate the cluster's size at about 20'.

Gem of the southern sky, open cluster NGC 4755 is known as the Jewel Box. Photo by Stephen Pattie (6-inch f/5.5 refelctor, hypered Tech Pan film, 15-minute exposure). Opposite page: Crux is loaded with deep-sky treasures. Photo by Stephen Pattie (200mm f/4 lens, hypered Tech Pan film, 20-minute exposure).

Viewed with a 6-inch telescope at low power, **NGC 4439** looks like an upside-down question mark. In my 17.5-inch scope NGC 4439 appears like a small, loose group of stars 3' in diameter. The cluster contains twenty stars ranging from magnitudes from 10 to 12.5. At 32x the 6-inch scope reveals only the brightest eight stars in this little group.

H5 is one of the most striking clusters in the area. My 6-inch scope at 80x reveals a small cluster of about twenty stars flanked by three brighter stars that form a prominent triangle. At the heart of the cluster lies a bright star shining at about 8th magnitude. This cluster has a diameter of approximately 5'.

At low power in the 6-inch scope **NGC 4349** takes on an egg-shaped appearance with three prominent dark lanes crisscrossing the cluster's central region. NGC 4349 is a huge, loose cluster containing over 200 stars, most glowing at magnitudes 11, 12, or 13. The sixty brightest members are clustered around a bright central star. The cluster's size appears to vary because of the incredible richness of the Milky Way in this vicinity. With a 6-inch instrument NGC 4349 appears to be 19' in diameter. A 12.5-inch scope gives the appearance of a cluster 12' across, while a 17.5-inch scope suggests a 9' diameter. View this group with low powers and you'll help it stand out from the dense background.

NGC 4337 is a small, tight cluster lying in a chain of stars that ends at a prominent yellowish pair of magnitude-7.5 stars. A 6-incher at low power shows this group as a small, hazy patch with a few faint stars. At medium power the cluster is halved by a dark lane. (This dark lane is difficult to see with larger apertures, however.) With a 17.5-inch scope at 118x the cluster appears to be made up of small groups of twenty to thirty 14th-magnitude stars. The cluster's diameter appears to be about 2'.

NGC 4103 is an interesting collection of some fifty bright stars in an arrow-shaped pattern. Most of the stars glow between magnitude 8 and 10. A 6-inch scope at medium power shows the head of the arrow with a highly compressed core of two dozen or so stars. In my 17.5-inch scope many chains of stars and dark lanes are visible. One dark hole just east of the cluster's center has a lovely pair of equally faint stars near its center. The overall size of this group is about 5'.

The most conspicuous feature of **NGC 4052** is the distinctive double V-shaped pattern formed by its brightest stars. The sixty cluster members form various chains. The bright star Theta[1] Crucis lies close by to the southeast.

The only other cluster in Crux listed in the *NGC* is **NGC 4184**, which lies just west of Acrux. The *NGC* lists this cluster as "much compressed and extremely faint." While scanning the region with my 17.5-inch scope, the only object I found was a very faint assemblage of tightly grouped stars near the limit of detection that may or may not be a true cluster.

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The Uppsala General Catalogue: *An Overdue Review*

by Robert Bunge

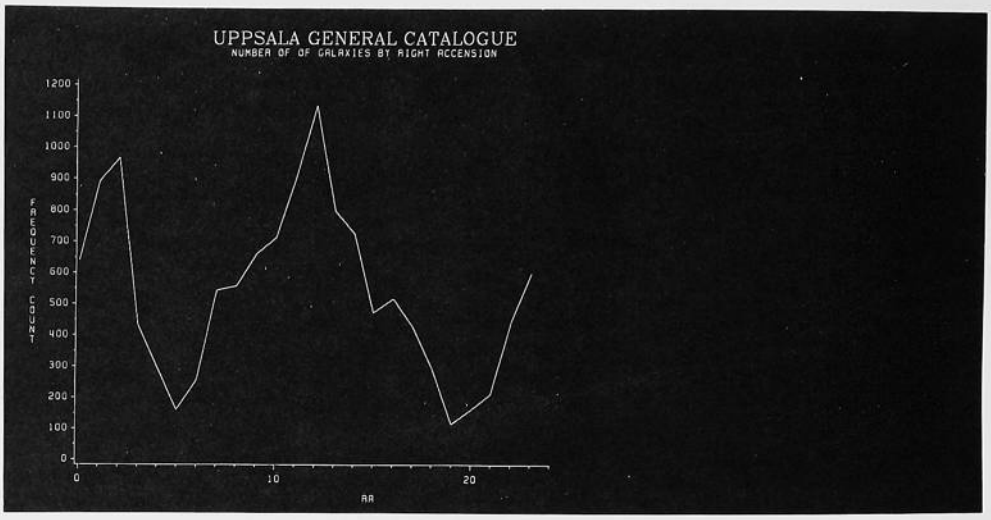
Up until about five years ago the vast majority of deep-sky observers had never heard of the *Uppsala General Catalogue of Galaxies (UGC)*. Today, however, because of larger backyard telescopes and atlases like *Uranometria 2000.0* that show many UGC objects, a greater number of observers at star parties are talking about the *UGC*.

The *UGC* is more or less a complete catalog of galaxies that are larger than one arcminute and lie north of -2.5° declination. It also includes galaxies smaller if they are brighter than magnitude 14.5. Most importantly, because of the care put into making the catalog and the type of information presented, the *UGC* is probably the most useful catalog for Northern Hemisphere galaxy observers — much more useful than the more common *Revised New General Catalogue (RNGC)*.

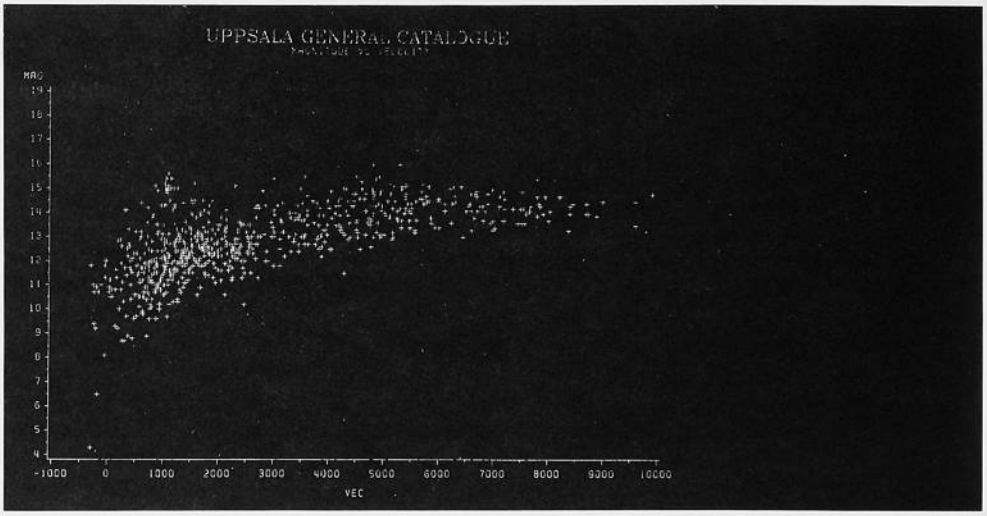
Unfortunately, the *UGC* is now out of print and very difficult to find. (When it was in print, its price tag was a non-trivial $90.) Even if you don't own a copy, or think you can get along without it altogether, it's important to understand information about *UGC* objects presented in today's atlases, catalogs and periodicals.

The *UGC* contains 12,940 galaxies, including 19 galaxies added later that received the designation "A" after their *UGC* number. Arranged in order of equinox 1950.0 right ascension, the catalog contains galaxies from photographic magnitude 4.3 to 19. Because of the way the catalog was developed, the magnitudes are most accurate when brighter than 15.7.

Perhaps the most important aspect of the *UGC* is the amount of care and time that was put into it by author Peter Nilson. An astronomer at the Uppsala Observatory in Sweden, Nilson spent years compiling the catalog before publishing it in 1973. Nilson painstakingly pored over each chart of the *Palomar Sky Survey (POSS)* using a 1.6x magnifier. Because of the large overlap Nilson used to ensure he missed nothing, every object passed through the magnifier at least three times.



This histogram shows the number of UGC galaxies per hour of right ascension plotted against right ascension. Dips at 5h and 19h show the Milky Way. Graphs by Robert Bunge.



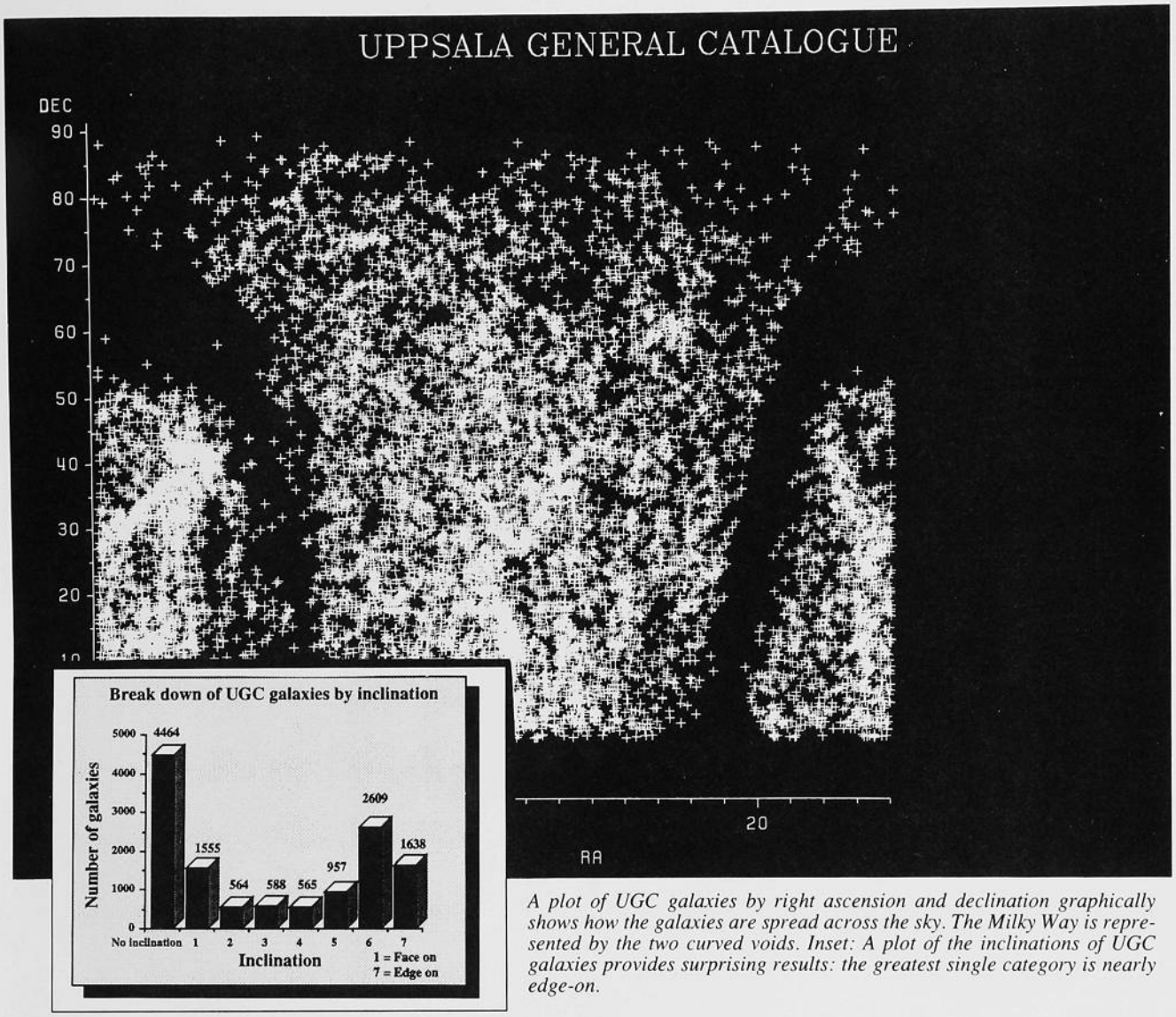
A plot of the brightness of UGC galaxies versus their radial velocities gives an indication of the three-dimensional universe.

With a separate index card for each object, Nilson then examined each of the plates three times to make sure his data agreed and that nothing was missed. This becomes an even more incredible feat when you consider that he did this for both the red and blue plates of the *POSS*.

Each of the three surveys took about one year, and the first of the three served as a warm up. Nilson said the results are pretty much based on the last two surveys. With the chart survey completed, Nilson typeset the catalog himself to ensure its accuracy. The result has been described as one of the most careful and most accurate catalogs ever assembled.

One of the most attractive points about the *UGC* for amateurs is the listing of galaxy sizes. Since Nilson inspected both the red and blue *POSS* plates, he listed dimensions for most galaxies in two colors. Nilson determined the red-light major axes of 12,934 galaxies and the blue-light major axes for 12,522 galaxies. While later studies by Harold Corwin of the University of Texas at Austin have shown that many of Nilson's sizes are about 10 percent too small, Corwin said the listed sizes should just about match what an amateur sees visually.

Wherever possible, Nilson took magnitudes for many of his galaxies from Fritz



A plot of UGC galaxies by right ascension and declination graphically shows how the galaxies are spread across the sky. The Milky Way is represented by the two curved voids. Inset: A plot of the inclinations of UGC galaxies provides surprising results: the greatest single category is nearly edge-on.

Zwicky's *Catalogue of Galaxies and Clusters of Galaxies* (*CGCG* or *ZWG*). Because of the method used by Zwicky to determine the photographic magnitudes of the galaxies, many astronomers apply a correction factor that at the most subtracts about half a magnitude. The amount of correction depends on where the galaxy is located. Subtracting an eighth of a magnitude yields a very approximate visual magnitude of a galaxy.

Since the faintest galaxy in the *CGCG* has a photographic magnitude of 15.7, Nilson was forced to estimate galaxies that were not in the *CGCG* but were larger than an arcminute and fainter than the *CGCG*'s limit. Nilson estimated these magnitudes from the *POSS* plates. He normally only estimated these objects to half a magnitude. Many of the *UGC* positions were also taken from the *CGCG*. These are normally accurate to a couple of arcminutes.

Other information amateurs will find useful includes the galaxy's inclination to our line of sight and the classification of most entries into Hubble's system of galaxy types. Nilson also supplied about 9,600 position angles and 800 radial velocities of the galaxies in the catalog. When available the velocities are handy because they can supply a sense of the distance to the galaxy and give the observer a better grasp of the construction of the universe. Nilson also included a cross reference for the *MCG*, a 1964 catalogue of 29,000 galaxies by B.A. Vorontsov-Vel'yaminov of Moscow University, which was also based on the *POSS*.

Another important part of the *UGC* is the notes section at the end of the volume. As anybody who has ever tried to identify individual galaxies located in a group knows, the process of figuring out which galaxy is which can be difficult. In the notes section Nilson included information on galaxies or group of galaxies that would not fit into the format of the catalog. The result is a wealth of information that is very handy. The notes contain information about shapes, sizes, questions Nilson had, and other miscellany.

If you are interested in looking at galaxies in the Northern Hemisphere, the *UGC* is a terrific source of information. Its sizes and inclinations alone make the *UGC* attractive to the amateur galaxy hunter. This is only strengthened by the quality of the catalog's magnitudes, a function of the *CGCG*. The notes section of the *UGC* is a great resource when you are buried under a wealth of galaxies in a single field of view and traditional sources of information have been exhausted. The *UGC*'s lack of errors and the consistency of its information are hard to beat, especially when you start to factor in the *RNGC*'s magnitude problems and numerous errors. But the single most attractive thing about the *UGC* is that all of this useful information is nicely gathered together in a single volume that doesn't require lots of space on your observing bookshelf.

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Observing the 400 Herschel objects is an excellent project for deep-sky fans. The Herschel list is published as a catalog by the Astronomical League and is available through clubs that belong to the League. The objects listed were selected from a compilation of 2,477 objects observed by William Herschel.

I started on the Herschel list several years ago. Working on the project from my rural home, I decided to observe all of the objects using telescopes no larger than 6-inches in aperture and to record any other noteworthy objects in the same field as the Herschel objects.

As I observed Herschel objects in Leo I came across several interesting galaxy groups that contain unusual objects. Backyard observers may want to follow up on these preliminary notes of mine and submit their observations to *Deep Sky*.

The unusual galaxy pair NGC 2968 and NGC 2964 is one of the most curious sights in the constellation Leo. Michael Sweetman made this sketch using a 6-inch f/10 refractor at 102x. All sketches in this article are by Michael Sweetman.

The NGC 2964 Group

NGC 2968 and **NGC 2964** are galaxies that show up well at low power. NGC 2964 is slightly the brighter of the two. At 102x NGC 2964 shows a brighter center fading outward. The galaxy's outer halo is slightly elongated northwest-southeast. NGC 2968 appears circular in shape and is slightly brighter toward its center. **NGC 2970** is visible faintly only with averted vision during the best moments of seeing. Considerably smaller than NGC 2964 and NGC 2968, NGC 2970 is elongated northeast-southwest.

In trying to pick up this group's faint members it helps to adjust the field so the suspected objects are in the center and the bright members near the edge. Alternating your eyes can also be helpful. It is not unusual for one eye to be more sensitive to low levels of light than the other.

The NGC 3226 Group

Galaxies **NGC 3226** and **NGC 3227** make a nice pair

Galaxies NGC 3226 and NGC 3227 form a curious interacting pair. Sketch made with a 6-inch f/10 refractor at 102x.

The rich NGC 3190 group offers a low-power field containing four bright galaxies. Sketch made with a 6-inch f/10 refractor at 102x.

Top left: The NGC 3686 group sports a low-power field containing four galaxies. Sketch made with a 6-inch f/10 refractor at 85x. Top right: Another bright group contains the galaxies NGC 3630 and NGC 3640. Six-inch sketch made at 102x. Above right: The NGC 3607 group sketched at 102x. Above center: The NGC 3379-84 group sketched at 102x. Above left: Not in Leo, NGC 4631 nonetheless showcases the author's sketching talent. Sketch made with the 6-inch f/10 refractor at 102x.

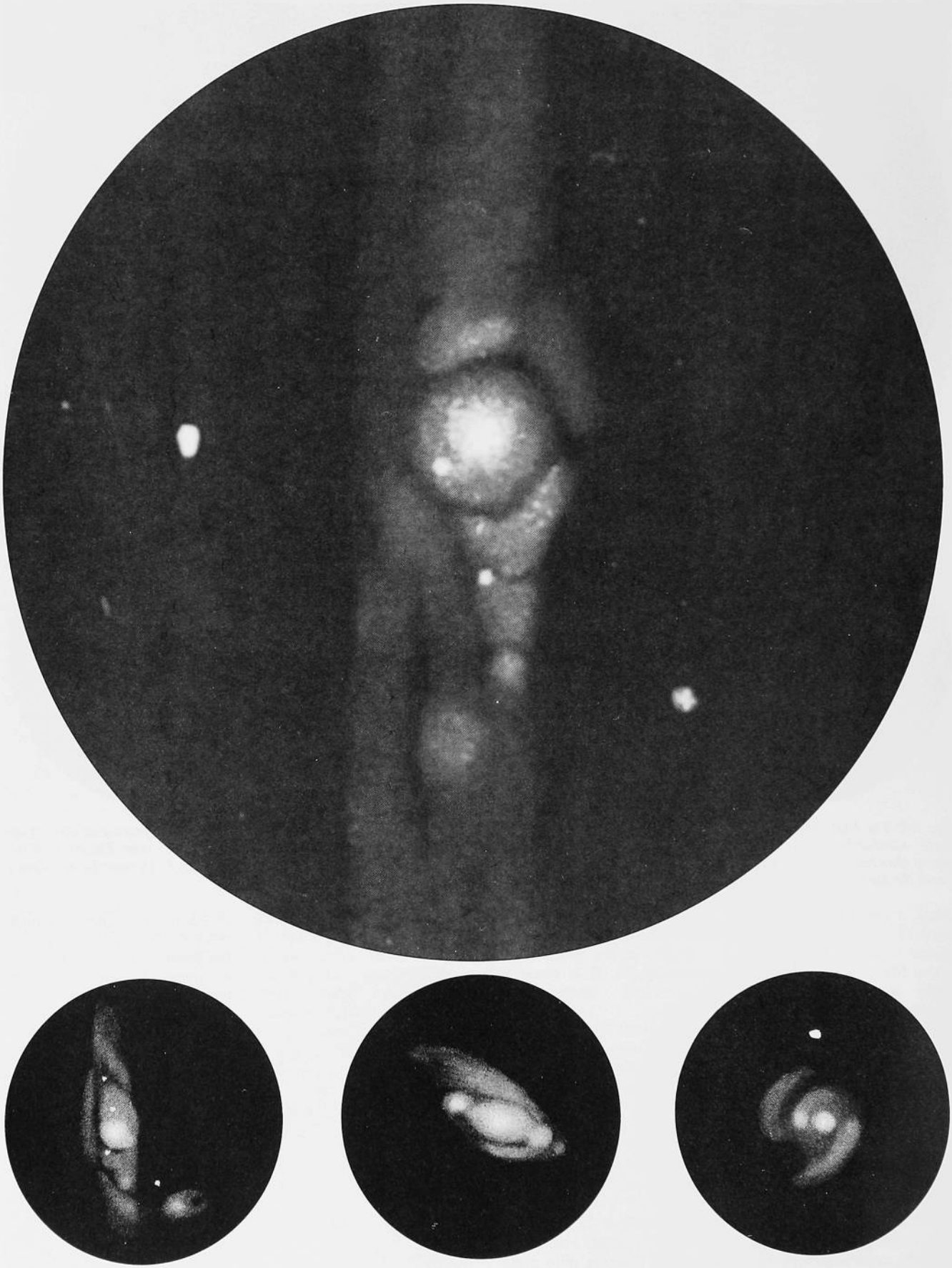
inside a low-power field. The galaxies' outer envelopes appear to touch. With averted vision NGC 3227 stands out as larger and brighter than its neighbor. I noted a slight elongation in the northwest-southeast direction. The envelope is brighter on the western side of the nucleus. A small bright spot is visible just east of the nucleus. The galaxy's core is visible surrounding the nucleus and shows a decidedly northwest-southeast elongation. During the best moments of seeing NGC 3227 appears mottled like a string of bright spots along the major axis. NGC 3226 is fainter and shows a slight increase in brightness toward the center. Slight elongation is observed in the southeast-northwest direction. NGC 3222 is spotted at low power using averted vision. It is round in shape and uniform in brightness.

The NGC 3190 Group

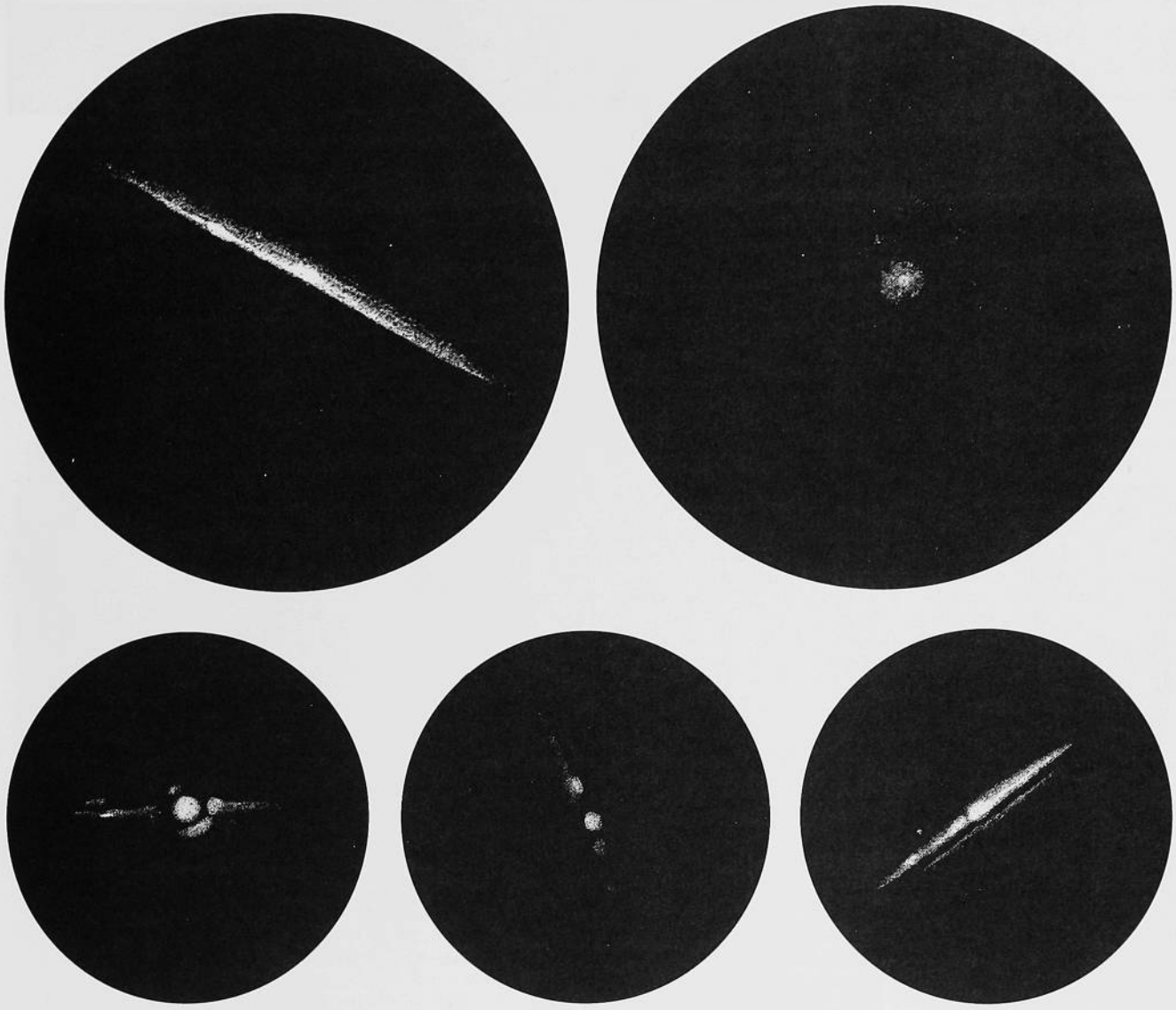
Both galaxies, NGC 3190 and NGC 3193, are easy to pick up at 51x and appear to be of about the same magnitude. NGC 3190 shows elongation while averted vision reveals a starlike nucleus with thin bright arms. A hook can be seen at the end of the P arm with a dark area appearing in the south side. NGC 3193 is bright towards the center but does not show a distinct nucleus. The envelope is bright and very irregular in shape, but it is only slightly brighter than NGC 3187, which is a small patch of light that can only be seen using averted vision. It's very difficult and smaller than NGC 3185. Although NGC 3185 is easier than NGC 3187, it still requires using averted vision. I suspected a slight increase in brightness toward the center. Spotting a 14th-magnitude galaxy with a 6-inch telescope shows how published magnitudes should be challenged by direct observation. The validity of magnitudes is best set by both positive and negative reports.

The NGC 3686 Group

At 38x this group appears as a chain of galaxies above the star 81 Leonis. Averted vision shows them the best. At high powers NGC 3686 appears as the brightest member. Circular in shape, it shows a slight increase in brightness toward the center. The envelope is irregular in shape. Elongated northwest-southeast, NGC 3684 is about the same size. At moments of good seeing a slight increase in brightness was noted toward the center. The galaxy NGC 3681 is smaller and harder to observe. It appears circular and, at best moments of seeing, shows a brighter nucleus than NGC 3686 and NGC 3684. Picking up NGC 3691 is a real challenge. It appears as a small patch of light, which I was able to observe by using averted vision.



This portfolio of Michael Sweetman's work shows the wide range of galaxies he has recorded. Top: NGC 4565 at 191x shows a bright, condensed core. Above left: Interacting galaxies NGC 4485 and NGC 4490 at 128x appear to be in contact. Above center: NGC 4449 shows peculiar structure at 128x. Above right: A faint star floats near NGC 4051 at 102x.



Top left: At 76x galaxy NGC 5907 in Draco appears like a smooth needle of silvery light. Top right: The unusual galaxy NGC 3139 in Sextans shows low surface brightness detail in its core at 146x. Above left: NGC 4216 in Virgo shows bright arms and an intense central hub at 102x. Above center: NGC 4179 sketched at 128x appears like a miniature version of NGC 4565. Above right: NGC 4762 in Virgo shows a fine dark lane at 102x.

The NGC 3630 Group

Table 1 shows six other galaxies other than the two observed with the 15cm scope. I did not spot any of the galaxies other than NGC 3630 and NGC 3640. At low power (38x) NGC 3640 is small and faint, appearing starlike with a faint circular envelope. NGC 3630 is also circular with a small, faint envelope. This object is best observed using averted vision. At 128x only NGC 3640 showed any detail. The nucleus is brighter and some elongation of the outer envelope can be seen. Bright spots can be picked up on both sides of the nucleus, although those on the eastern side show best. Several small patches were picked up just outside the main envelope. A few starlike objects can be spotted with averted vision.

My observations suggest that although an instrument might not be large enough to show a galaxy's whole disk, bright H II clouds can sometimes be picked up on the outside of the disk. Observers should look outside a galaxy's envelope as well as inside for details.

The NGC 3607 Group

I found this group easily at 38x. NGC 3607 appears as the brightest member and shows a star-like nucleus. With a little magnification (102x) NGC 3607 shows a circular core with a faint envelope and a slight northwest-southeast elongation. Averted vision shows some mottling around the nucleus. NGC 3608 displays a bright center, which fades rapidly into an envelope with an irregular shape. There is also a slight mottling around the nucleus. Using averted vision, NGC 3605 was hinted at as a small nebulous spot.

The NGC 3384 Group

NGC 3379 and NGC 3384 are the primary pair of this group and are easily picked up at 38x. Both galaxies showed a variety of detail, depending on the magnification used. It took averted vision and gentle sweeping of the field to pick up NGC 3389. At 102x NGC 3384 is not as bright or as large as NGC 3379. The outer envelope of NGC 3379 is slightly elongated and is brighter on the western side of the nucleus. The eastern edge of the envelope shows a slight increase in brightness and appears as a short arc.

Even with a small scope observing groups of galaxies can be fun and rewarding. Now when I look for a certain object, I look for all the objects shown on the charts that are in the same field. As beginning observers we can easily get into the habit of looking for a single object. Breaking that habit expands our observing pleasure and capabilities.

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Deep Sky Reports
An Australian Sketchbook
by Gerd Bahr-Vollrath

Ever since I moved from cloudy and frosty Europe to sunny Australia a few years ago, I became hopelessly addicted to astronomy. The stunning naked-eye views of the southern Milky Way were enough to convince me that a telescope was the only alternative to television.

After considering several factors such as portability, flexibility and convenience of use, I settled for a popular-brand 8-inch f/10 Schmidt-Cassegrain telescope. Considering the limited aperture, the deep-sky views it provides are very satisfactory.

For eyepieces I was not willing to make concessions, and so I acquired a comprehensive set of Nagler and Ultra Wide Angle "heavyweights." Those monsters may not be cheap, but they make sure that you get the most observing pleasure. I also organized a set of 2" "Whizz" filters that allow me to scrutinize subtle detail in nebulosities. In order to find what I am searching for, I constructed an 80mm finder scope, comfortably reaching down to magnitude 11.5. From my observing site at latitude -26.5° I get the best of both worlds. I can observe as far north as 40 degrees and I get all the southern hemisphere.

My back yard offers reasonably dark skies with a naked-eye magnitude of better than 6. By furthermore considering that the weather here in Queensland delivers a good dozen transparent nights per month, you will understand why I don't even own a television anymore.

After some months of scanning the skies I spent some thoughts on how to best document all those thrilling sights. Photography was out of debate, because all the additional equipment would have overstressed my budget, not to mention all the hassle involved for making long-term guided exposures (I'm terribly lazy!). So the obvious answer was to sketch all those pretty photons that found their way to my retina. As I occasionally work as a freelance cartoonist and illustrator, I knew some "tricks of the trade" and soon came up with satisfying results.

I use smooth-surfaced black paper for the backdrop, as I have an easier time making "positive" drawings. I also found that the reflection of the red light off white paper interfered with the dark-adapted eye. I achieve the crisp star images with a 0.25mm technical pen, filled with white ink. Should I however make a mistake, I simply cancel the star with black ink. The nebulous structure is added with a variety of white pencils. A little rubber-pad glued to one of the pencils is used to smear the pencil marks into the desired precise shape.

I have discovered (perhaps even pioneered?) a technique on how to sketch the very demanding globular clusters using ink only. Most globulars seem to consist of several layers of superimposed stars, varying in density and brightness. This probably accounts for the pronounced three-dimensional appearance of the larger specimens. On most sketches I have seen this problem solved by drawing a fuzzy background with a pencil and then the brighter stars were added on top. But even my humble 8 incher shows this background fuzz as many individual faint stars. So I plot hundreds of ink dots in the desired shape and density and then use an eraser-gum to faint-out these dots, so they become an ill-resolved haze of stars. Then I continue with the next layer of stars.

When I take the sketches back indoors, I sometimes have to make minor corrections. When drawing under a dim red light you tend you over-enhance subtle contrast features. When viewed under normal light-levels, you may find the sketch as being too bright and contrasty. I do these corrections quickly, so that my memory is still fresh. The finishing touch is a sprayed-on layer of a flat overcoat which protects the fragile pencil work.

The sketches in this article give you a range of different objects I have captured on paper. I hope they will water your mouths sufficiently, so that you may end up calling your travel agent on a quote for a trip to Aussie. I could not resist to enclose the bright galaxies NGC 55 and NGC 253. These members of the Sculptor group are some of the best galaxies you can view. There is so much detail, that I even could spot H-alpha regions by blinking with a UHC filter.

The 8th-magnitude spiral galaxy NGC 55 in Sculptor sketched by Gerd Bahr-Vollrath with an 8-inch f/10 SCT at 100x.

NGC 246 in Cetus is a challenging low surface brightness planetary nebula. It features a nice circular smoke ring with brighter zones near its edges. Not many observers know that NGC 1360 is a pretty and quite bright planetary nebula in Fornax. It has an oval shape with a uniform brightness distribution which made me mistake it for galaxy when I first came across this object. The bright central star stands out prominently.

The Fornax galaxy cluster is an impressive sight, sporting more than a dozen bright mostly elliptical galaxies in a compact field. I managed to squeeze nine members into a 55' field of view. NGC 1365 lies nearby and it is one of my all time favorites, as it revealed its huge spiral arms to me.

Going further east to the inconspicuous constellation of Columba you will come across the pretty globular cluster NGC 1851. To me it appeared like a scaled-down version of 47 Tucanae, featuring a very bright and compressed core. M46 passes almost overhead and the supposedly challenging planetary NGC 2438 superimposed onto the cluster showed up even in my finder. The 8 incher shows it as a nifty circular smoke ring with two faint stars shining from it.

Reserved for southern hemisphere dwellers only are the Magellanic Clouds. The detail they present could fill an entire book. Imagine having all the goodies of our Milky Way compressed into a few degree.

NGC 2070, the Tarantula, is my favorite nebula. The bright core displays a wealth of detail and the outer filaments resemble a spider's fangs and legs. My humble attempt to sketch this sight is simply dwarfed by its live appearance.

NGC 104 (47 Tucanae) is the brightest globular cluster our Galaxy can offer. It looks like an exploding ball of stars spilling outside of a low-power field. We southerners keep having arguments about which globular cluster is the most impressive: Omega Centauri or 47 Tucanae. What do you think?

I have also included a sketch of M42 in this article, just to prove that deep-sky objects do not appear upside-down from here. (It is also a myth that you can see the far side of the moon from Australia!)

There is so much more to write about the adventurous southern skies. I hope to share some more impressions with you in the near future.

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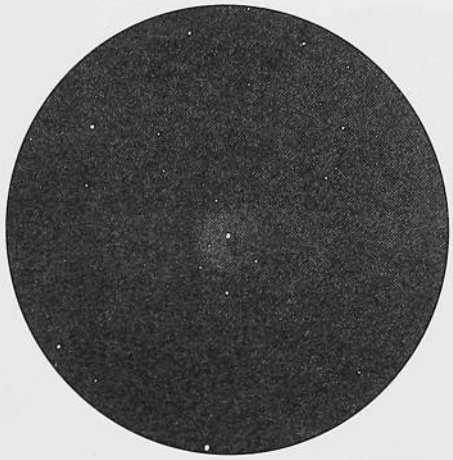
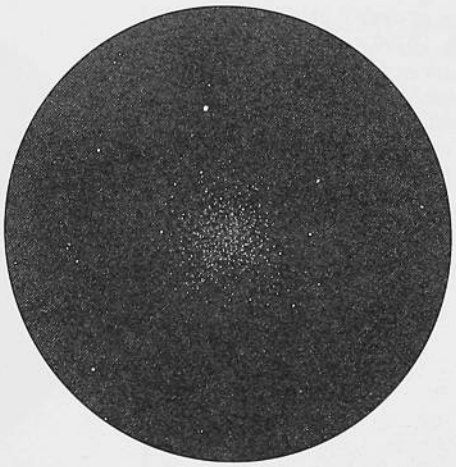
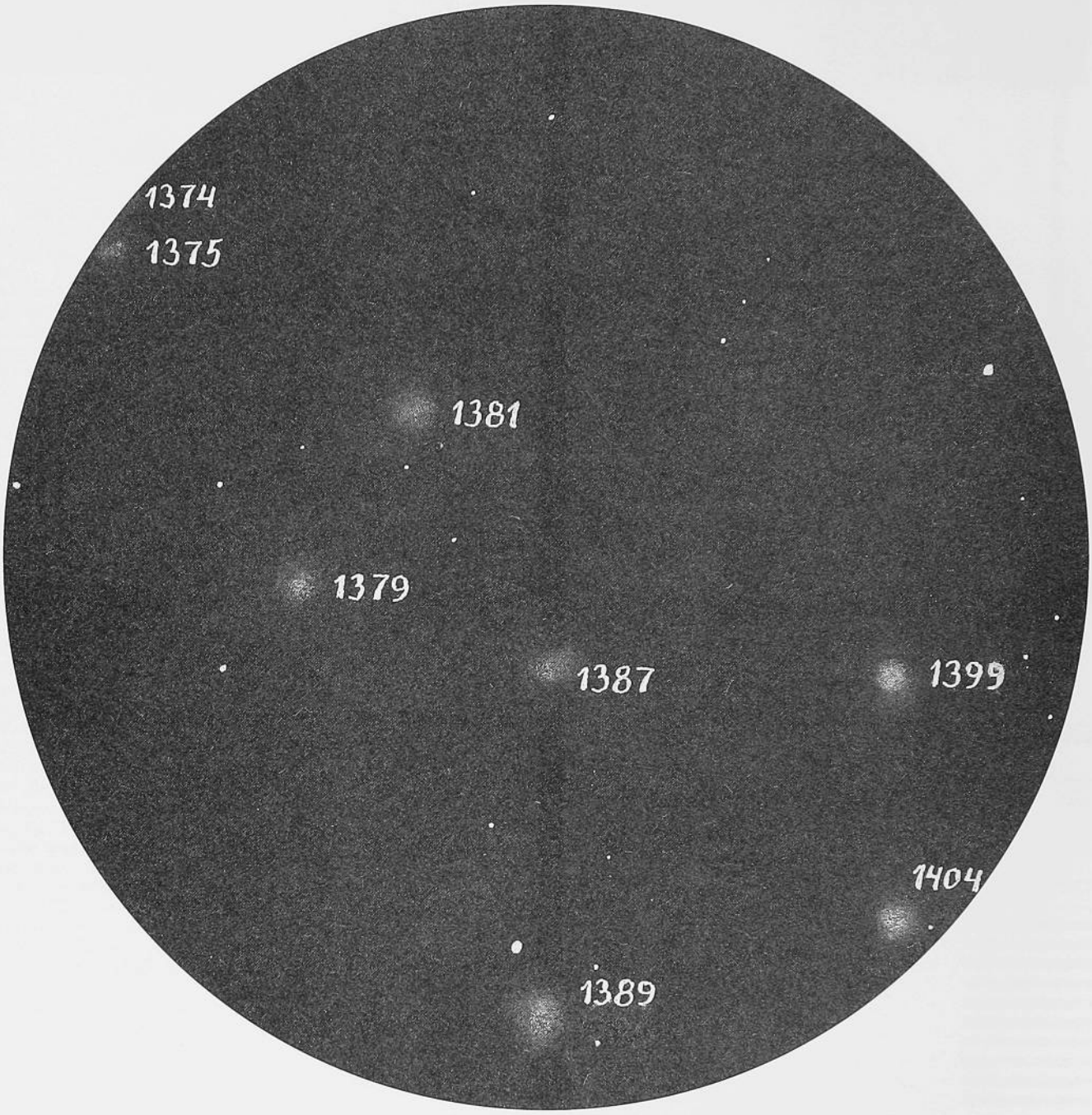
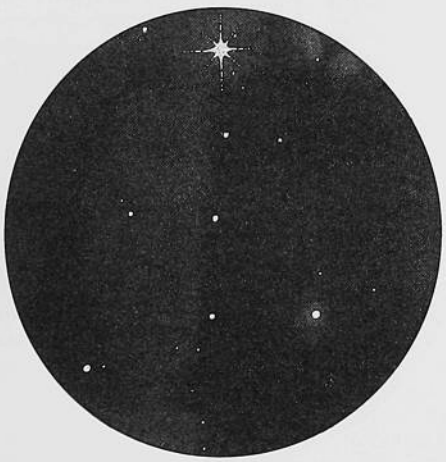
Above: The bright globular cluster NGC 104 (47 Tucanae) sketched with an 8-inch f/10 SCT at 230x. All sketches in this article are by Gerd Bahr-Vollrath.
Far right: Globular cluster NGC 288 sketched with an 8-inch f/10 SCT at 100x.
Right: Planetary nebula NGC 246 sketched with an 8-inch f/10 SCT at 100x.







Above: The center of the Fornax Galaxy Cluster sketched with an 8-inch f/10 SCT at 63x. Numbers refer to NGC designations.
Far right: Galaxy NGC 1365 in Fornax sketched with an 8-inch f/10 SCT at 100x.
Right: Planetary nebula NGC 1360 sketched with an 8-inch f/10 SCT at 63x.



Above: The Orion Nebula sketched with an 8-inch f/10 SCT at 100x.
Far left: The Zeta Orionis region sketched with an 8-inch f/10 SCT at 63x.
Left: Globular cluster NGC 1851 sketched with an 8-inch f/10 SCT at 155x.

Above: NGC 2070, the Tarantula Nebula, sketched with an 8-inch f/10 SCT at 155x.
Far right: NGC 253 sketched with an 8-inch f/10 SCT at 100x..
Right: M46 and planetary nebula NGC 2438 sketched with an 8-inch f/10 SCT at 155x.

Deep Sky Reports
Reader's Page
by Steve Coe

Springtime always seems like a fantastic time to observe. Those winter goodies are still up early in the evening, and later on three magnificent constellations chock full of galaxies rise above the eastern horizon. Leo, Virgo, and Ursa Major keep dedicated galaxy hunters busy all night long during the springtime. The following observations were made by Dave Fredericksen and me with a 12.5-inch f/6 reflector.

NGC 2903 is one of the best non-Messier galaxies. It was easily visible in a 10x50 finder scope. At 175x this galaxy is briht and appears mottled across its surface with a strongly bright core. An isolated bright spot lies about 4' away from the core.

NGC 3098 is a pretty faint and small galaxy, appearing to be elongated by a ratio of 2:1 at 120x. During moments of good seeing this object shows a stellar core.

NGC 3162 is pretty faint, pretty small and round at 120x. At high powers this galaxy appears to be somewhat brighter in its central regions.

NGC 3190 is the brightest galaxy of several that lie together in a group. **NGC 3185** is pretty faint, elongated, and has a somewhat brighter middle. **NGC 3187** is very faint and elongated. NGC 3190 itself is pretty bright, round, and has a very bright middle. A hint of a dark lane is visible during moments of good seeing. **NGC 3193** is pretty bright, round, and has a much brighter middle.

NGC 3226 and **NGC 3227** form a pair 50' east of Gamma Leonis. NGC 3227 is pretty bright, considerably elongated, and has a bright nucleus. NGC 3226 is pretty bright, round, and has a bright nucleus at 160x. These galaxies appear to overlap each other, even at high powers.

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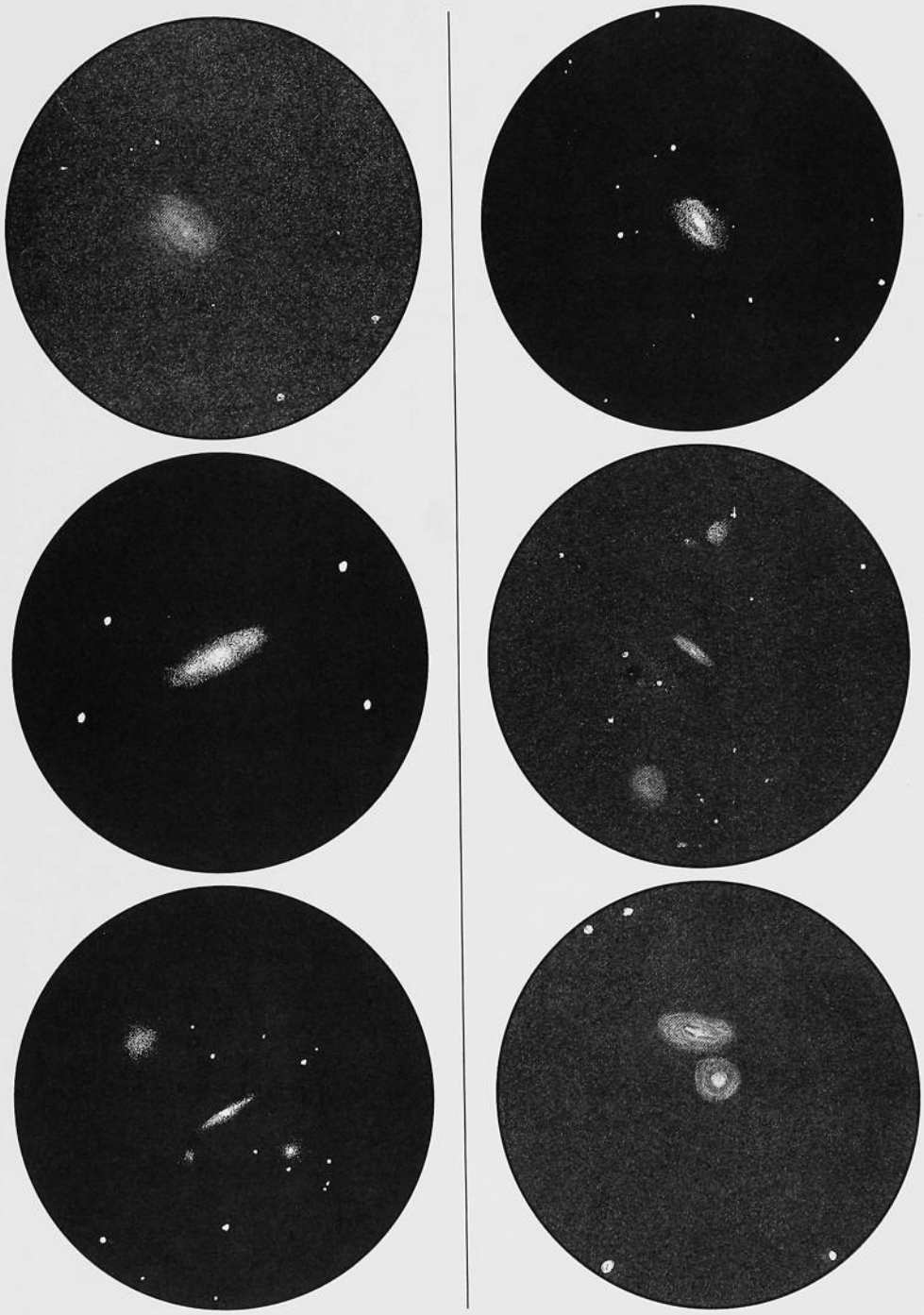

Top left: NGC 2903 sketched by Bob Buchheim of Long Beach, California, who used a 13.1-inch f/4.5 reflector at 100x. Top right: NGC 2903 sketched by Tom Polakis of Tempe, Arizona, who used a 13.1-inch f/4.5 reflector at 166x. Left center: NGC 2903 sketched by Gordon Bond of Middlesex, New Jersey, who used a 10.1-inch f/4.5 reflector at 96x and a nebula filter. Right center: The NGC 3190 galaxy group sketched by Bob Buchheim with his 13.1-inch f/4.5 reflector at 100x. Bottom left: The NGC 3190 group sketched by Tom Polakis with his 13.1-inch f/4.5 reflector at 115x. Bottom right: The unusual pair of galaxies NGC 3226 and NGC 3227 sketched by Dennis E. Hoverter with his 8-inch f/4.5 reflector at 150x.

Deep-Sky Challenges
A Round of Springtime Challenges
by Phil Harrington

While many of us will spend our observing time over the next few months looking for galaxies, there are deep-sky objects closer to home that can also test our skills. A little known open cluster, an often-confused planetary nebula, and a potentially frustrating globular cluster are among the challenges I'll offer in this column. Of course I'll throw in a couple of galaxies just to keep everyone happy.

Binoculars: ***Upgren 1***
Stats: R.A. 12h 35.0m,
Dec. +36°18′
Constellation: Canes Venatici
Magnitude: ?
Size: 15′ Open Cluster

Have you ever seen the open cluster Upgren 1? I'll bet you have maneuvered your scope all around it if you have ever explored Canes Venatici. Upgren 1 is a bright, poor group of ten stars scattered across 15′ located about 5° southwest of Cor Caroli (Alpha Canum Venaticorum).

Seven-power glasses reveal four 7th-magnitude stars (three of which lie in a short, straight line) along with a couple of fainter stars. Larger binoculars add a few more points of light to this group, which lies at a distance of 140 parsecs. Although studies show it is a cluster, Upgren 1 never really impresses me as much more than a chance asterism. What do you think?

2- to 3-inch scopes: ***NGC 4565***
Stats: R.A. 12h 36.3m,
Dec. +25°59′
Constellation: Coma Berenices
Magnitude: 9.6
Size: 16′x3′ Galaxy

Magnificent Virgo is home to many striking galaxies. NGC 4565 is one of the finest. Found along the cluster's northern outskirts in Coma Berenices, NGC 4565 is one of the sky's outstanding examples of an edge-on spiral. At 10th magnitude NGC 4565 is bright enough to offer a pleasing view in nearly all optical instruments.

To find NGC 4565 first center your attention on 17 Comae Berenices, located on the eastern edge of the Coma star cluster. The galaxy lies less than 2° to the east. In smaller instruments NGC 4565 appears as a grayish "needle" of light accented by a sharp centralized point. NGC 4565 measures 16′ by 3′, but visual observers will see it as about two-thirds of this size. Large telescopes show the spiral's characteristic dark band of nebulosity surrounding the outer rim along with the galaxy's distinctive central bulge.

4- to 6-inch scopes: ***NGC 5128***
Stats: R.A. 13h 25.5m,
Dec. -43°01′
Constellation: Centaurus
Magnitude: 7.0
Size: 18′x14′ Galaxy

Observing from Long Island has its advantages and disadvantages. While most of the island suffers from a disastrous level of light pollution, the south shore along Fire Island enjoys clear, unobstructed views of southerly declinations. Scanning out over the Atlantic we can penetrate to as low as declination -45° or more on clear nights. One of the greatest challenges we enjoy is seeing just "how low can you go" — how far south can we see?

NGC 5128 lies in Centaurus at declination -43° and culminates a mere 7° above the horizon at my latitude of 40° North. NGC 5128 is a peculiar S0 type galaxy famous for the broad dark lane that bisects it. From a more advantageous observing site this lane is detectable in 4-inch instruments and may even be detected with 11x80 binoculars. However, viewing from a northern, light-polluted location, NGC 5128 is only faintly perceptible in a 6-inch telescope at 96x. The galaxy itself is round and diffuses evenly outward from what must be a bright core that is eclipsed from view by the absorption lane.

NGC 5128 is popularly referred to as Centaurus A because of its strong radio emissions. Once thought to be the result of two galaxies colliding, the radio noise is now believed to be generated by tremendous internal upheavals from within the galactic core.

12- to 14-inch scopes:
NGC 2474/5 and PK 164+31.1
Stats (NGC 2474):
R.A. 07h 57.98m,
Dec. +52°51.5′
Constellation: Lynx
Magnitude: 13.9p
Size: 0.6′ Galaxy
Stats (NGC 2475):
R.A. 07h 58.01m,
Dec. +52°51.7′
Constellation: Lynx
Magnitude: 13.9p
Size: 0.8′ Galaxy
Stats (PK 164+31.1):
R.A. 07h 57.8m,
Dec. +53°25′
Constellation: Lynx
Magnitude: 14p
Size: 400″ Planetary nebula

Will the real NGC 2474 please stand up? That was the question being asked by many amateur astronomers almost a decade ago. Back then, when large aperture "light buckets" were just catching on, most deep-sky observers had yet to explore the universe beyond 12th magnitude. And so it was that in the February 1981 issue of *Sky and Telescope*, that Walter Scott Houston suggested that readers might enjoy viewing a planetary nebula with the dual NGC listing of NGC 2474 and NGC 2475. He noted, however, some discrepancy in the object's visibility. One correspondent saw the nebula through an 8.5-inch telescope while another missed it with a 10-inch. Given that both were accomplished observers viewing under good skies, how could this be?

The mystery of NGC 2474/5 was soon resolved. It seems that many people were simply looking at the wrong object. An article by Nancy and Ron Buta (the title of which I borrowed for the opening line of this discussion), appeared in the April 1981 *Sky and Telescope*. The Butas' clarified that NGC 2474/5 is actually a close pair of elliptical galaxies. Discovered by William Herschel, NGC 2474 is described in Dreyer's *New General Catalogue* as "faint, pretty small, extended?, brighter middle, very small star?, large star north following". NGC 2475 is simply noted in the *NGC* as forming a double nebula with NGC 2474.

If you zero in on the object's position you will find a faint though perceptible object set just southeast of a 9th-magnitude field star, the "large star" listed in the *NGC*. Through my 8-inch f/7 Newtonian at 119x, NGC 2474 was clearly seen as a small, faint patch of light highlighted by a stellar core. The same instrument failed to reveal NGC 2475. With my 13.1-inch f/4.5 reflector I could split both galaxies at 211x.

If NGC 2474 and NGC 2475 are galaxies, then what was the planetary that Houston referred to? The Butas' article cleared up that bewilderment by identifying the nebula as PK 164+31.1 from L. Perek's and L. Kohoutek's *Catalogue of Galactic Planetary Nebulae*. Located about 0.5° north of the galaxies, this planetary was discovered in 1939 at Harvard Observatory on photographic patrol plates. PK 164+31.1 is a ring-type nebula with two distinctly brighter east-west knots. Astronomers at the time must have mistaken these clumps for the *NGC* entries, causing over four decades of confusion.

Using a 12mm eyepiece and a nebula filter my 8-inch reflector displayed only the planetary's brightest, eastern nebulous knot.

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Smithtowwn, NY 11787

The galaxy NGC 5128 photographed by David Healy (14-inch f/10 SCT, hypered Tech Pan film, 48-minute exposure.

Small Scope Showcase

Northbound

by Alister Ling

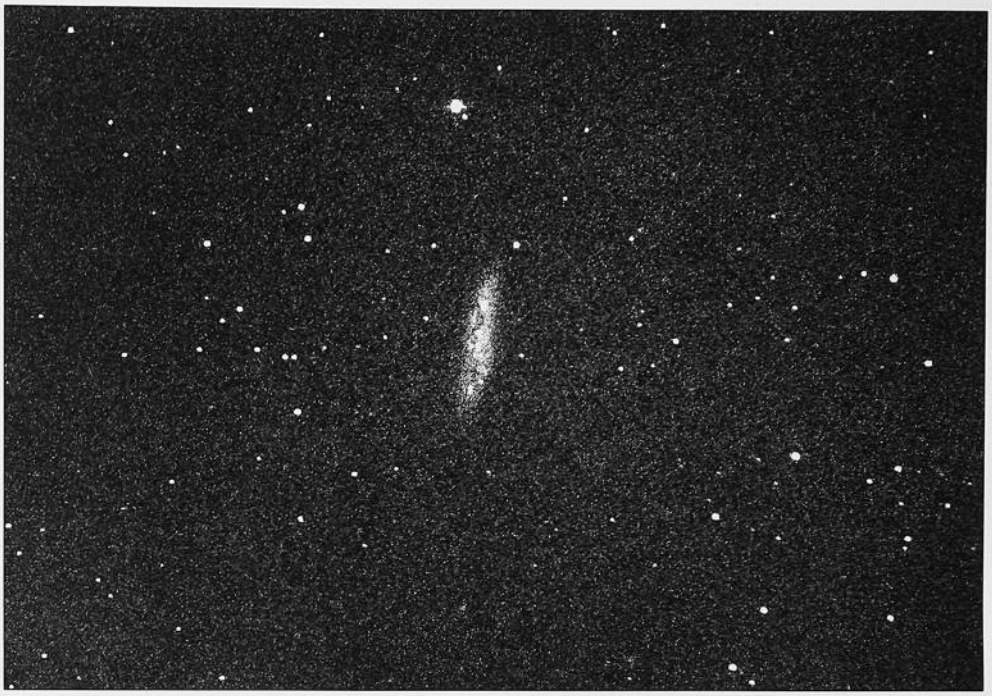
The far north. One can imagine the mystery associated with such a place. Hidden, inaccessible, to reach it requires a journey filled with deceptive routes. But not so with the stellar north. Many paths are open to observe a variety of deep-sky objects, some unfamiliar, some classic.

Let's start on the southern fringes with a late-winter unknown currently riding high overhead. **NGC 2281** can be found a degree north of the midpoint between Castor and Beta Aurigae. This sparkler of an open cluster is a nice way to start an observing session. You've probably just finished collimating your scope after a quick set-up and your eyes haven't yet fully dark-adapted. Why waste your time looking at galaxies? Your eyes simply aren't prepared to detect the faint haloes of ellipticals or the delicate arms of spirals so early on in the night.

Even from an urban observing site NGC 2281 stands out nicely from the background sky. The lack of dozens of faint field stars is testimony to its distance from the galactic plane. Switching to medium powers allows you to see three delightful pairs of stars, two sets of which form part of a small diamond-shaped asterism. The pairs are easy because they have separations of 10" to 15".

William Herschel discovered this object just over two hundred years ago on a March evening. Relatively few people since have seen this group because it lies so far off the beaten path of the Milky Way and therefore more alluring objects in nearby Gemini. Give this one a try.

As we swing our scopes further north and east we arrive at Ursa Major — galaxy country. **NGC 2841** is easy to locate a couple of degrees west of Theta Ursae Majoris. At low power in an 8-inch scope its bright central core can be seen, surrounded by an oval halo, elongated northwest-southeast, about two times longer than it is wide. In contact with the northwest edge is an 11th-magnitude star. An 8th-magnitude star blazes one diameter away, following NGC 2841 out of the field.



The knotty, dusty galaxy M108 is one of the finest examples of an edge-on system in the sky. Photo by Lee C. Coombs (10-inch f/5 reflector, 103a-O film, 15-minute exposure).

As with all deep-sky objects try applying some higher magnification after your first look. Can you detect a 13th-magnitude star just to the west and a slightly fainter one just east of the 11th-magnitude star?

This small right-angle triangle of stars is a useful memory tool if you want to search for a supernova in this galaxy. Although slight haze or light pollution may hamper your seeing nebulosity, the stars should still be visible. At the derived distance of NGC 2841 a type I supernova would have an expected brightness of about 12th magnitude, which is readily accessible with smaller scopes even from city locations.

Supernova hunting is a relaxing way to spend an evening. Even if you don't find one your prolonged searching trains your eye to detect subtle details in the galaxy itself. H II regions tend to hide from quick glances. As with all searches for novae be careful of false alarms. Don't jump too quickly to the phone.

Being in Ursa Major we can sweep in no time to a most familiar area, the Big Dipper. It's like the Greenland of the Arctic — you can't miss it. A short hop from the lower right corner of the bowl lie Messier numbers 97 and 108.

M108 is a most fascinating galaxy, in many ways visually similar to M82. M108 has a bright stellar core meshed in a very elongated and mottled body. My last "official" observation of this galaxy was a decade ago with my 10-inch scope at low power. In those days, my notes were poor at best; they say little more than "elongated."

It is surprising that there are few good modern reports on M108. There is talk of good mottled detail in 12-inch scopes, but nothing more specific. How about we all give it a good high-power look this spring? Boost the magnification as high as your scope will allow. Bright and dark features can only be noted when they subtend an angle big enough for your visual system to catch. Use a dark hood over your head to keep stray light out. Large scope owners may want to try observing with an off-axis mask to simulate a smaller instrument. Send your results in for the *Readers' Page*.

Now that you're probably geared up to see detail, slip southeast to **M97**, the Owl Nebula. Try to see the dark "eyes" but resist the temptation of throwing on a filter. Although a filter will make this large planetary nebulae appear brighter relative to the background sky, it may not add detail. Depending on the emission characteristics of the Owl, a filter may impair your view.

The Owl's eyes are regions that contain less nebulosity and hence appear darker. A nebula filter will only help to fill these

One of the great challenge objects for small scope users, the Owl Nebula in Ursa Major offers dark "eyes" only to patient viewers. Photo by Martin C. Germano (8-inch f/10 SCT, hypered Tech Pan film, 105-minute exposure).

in, not make them stand out. Perhaps the best method is to crank the power up to the limit, thereby "stretching" out the glow until you can see the darkness through it. The central star would also become visible. Can this be done with an 8-inch or 10-inch scope?

The first time I saw the Owl Nebula, with my 4.5-inch reflector, I was sure I had a comet! My reasoning was that because the Owl was reputed to be one of the toughest Messier objects and this object was easy, I was looking at an imposter. A quick glance at a photograph erased my thoughts of instant fame. So much for observing guides; check things out for yourself.

Poleward of Ursa Major we find mostly galaxies. Owners of equatorial scopes typically shun this region because it can become quite difficult to maneuver their scopes without getting frustrated. However, there is a small planetary nebula well worth the effort to see. At 18" across and glowing at 10th magnitude, **IC 3568** in Camelopardalis is a fairly easy target.

Dobsonian users can hop from Polaris and off at a right angle from Delta Ursae Minoris. Equatorial owners should start at Epsilon Ursae Majoris and proceed bowlward along the Dipper's handle from Alcor and Mizar. Slew your telescope northward and stop at the appropriate place indicated in your finder scope.

A greenish blue hue from one of the many 10th-magnitude stars told me which one was really the planetary. Checking with the O III filter I could see IC 3568 shining intensely brighter than the surrounding stars. It is one of the easiest objects I've ever "blinked." Back in 1918, Lick Observatory astronomer Heber D. Curtis recorded that the nebulosity in this object was captured on film five times more quickly than the central portion of M42!

At such a high declination the sky drifts by very slowly, thus allowing Dobsonian users to use higher powers than normal. When viewing IC 3568 a flat disk can be seen surrounded by a faint halo not quite twice its size. During moments of good seeing a central star pops into view.

The only other bright object closer to the pole than IC 3568 is the ancient open cluster **NGC 188**. Equatorial owners have to do a bit of gymnastics to get there since NGC 188 is almost on the other side of the pole. Low powers show a field of sparkling points, while medium powers split the cluster wide open. Either way leads to a pretty sight.

Polarissima, a.k.a. **NGC 3172**, is the closest NGC object to the pole. I have yet to hear of anybody locating it in a 10-inch scope, so consider it a challenge. Reports from owners with 12.5-inchers are contradictory. Some say easy, others say difficult. Transparency and experience are the two crucial factors here.

The far north contains an enjoyable alternative to the inevitable Virgo cluster. Why not make a visit?

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Canada

Double Stars
Anticipating NGC 2516
by Brian Skiff

Near the top of my observing list for southern hemisphere viewing in February and March is the bright open cluster NGC 2516, located in western Carina. Its basic appearance is similar to Messier 7 near the Stinger of Scorpius, an object more familiar to northern observers.

Both clusters are faintly sparkling naked-eye objects at least a degree across and their brightest stars are between fifth and sixth magnitude; they even have similar ages (near 100 million years) and distances (450 pc). While the brightest stars in Messier 7 are rather ordinary, NGC 2516 boasts a number of red giants and stars with peculiar spectra. The cluster contains at least 360 members brighter than V magnitude 14.5, so it is much richer than Messier 7. And since it lies 16° off the galactic plane, the members are not swamped by a starry Milky Way background.

There is even interest for double star observers: .in a recent photometric study of the cluster (the latest of many published over the last 35 years), J. Dachs and H. Kabus discussed the collection of pairs catalogued in the cluster field. The astronomers obtained photometry of individual stars of many of the pairs for the first time, and concluded that most of them are real, and not chance alignments of cluster stars or field stars.

The table given below lists the pairs studied by Duchs and Kabus in order of increasing magnitude; the stars are identified on the accompanying chart. Like all the open clusters catalogued in the *NGC* and *IC*, NGC 2516 was scoured by early observers for close pairs, so at least the relatively close pairs were discovered by John Herschel, Innes, and others before World War I. Given that the distances to most open clusters are large (a kiloparsec or more), few of the visual binaries are physical. Open clusters are not lacking in real pairs, but because of their distances they can be observed usually only as spectroscopic binaries.

Nevertheless, it is fun to be able to view many pairs in a small area. Fairly close pairs are surprisingly unusual in open clusters, the ordinary circumstances being that the stars are spaced more-or-less uniformly from one another.

From Chile with my 6-inch telescope, I foresee no difficulty in picking up even the faintest of the listed pairs wider than 10 arcseconds. The only real challenge may be identifying them in the matrix of cluster stars.

Success with the closer ones will depend on their magnitudes and magnitude differences, so let's take them on a case-by-case basis. Having viewed about 800 pairs with the 6-inch scope, I can make pretty confident predictions about the resolvability of any pair given the magnitudes and separation of the stars.

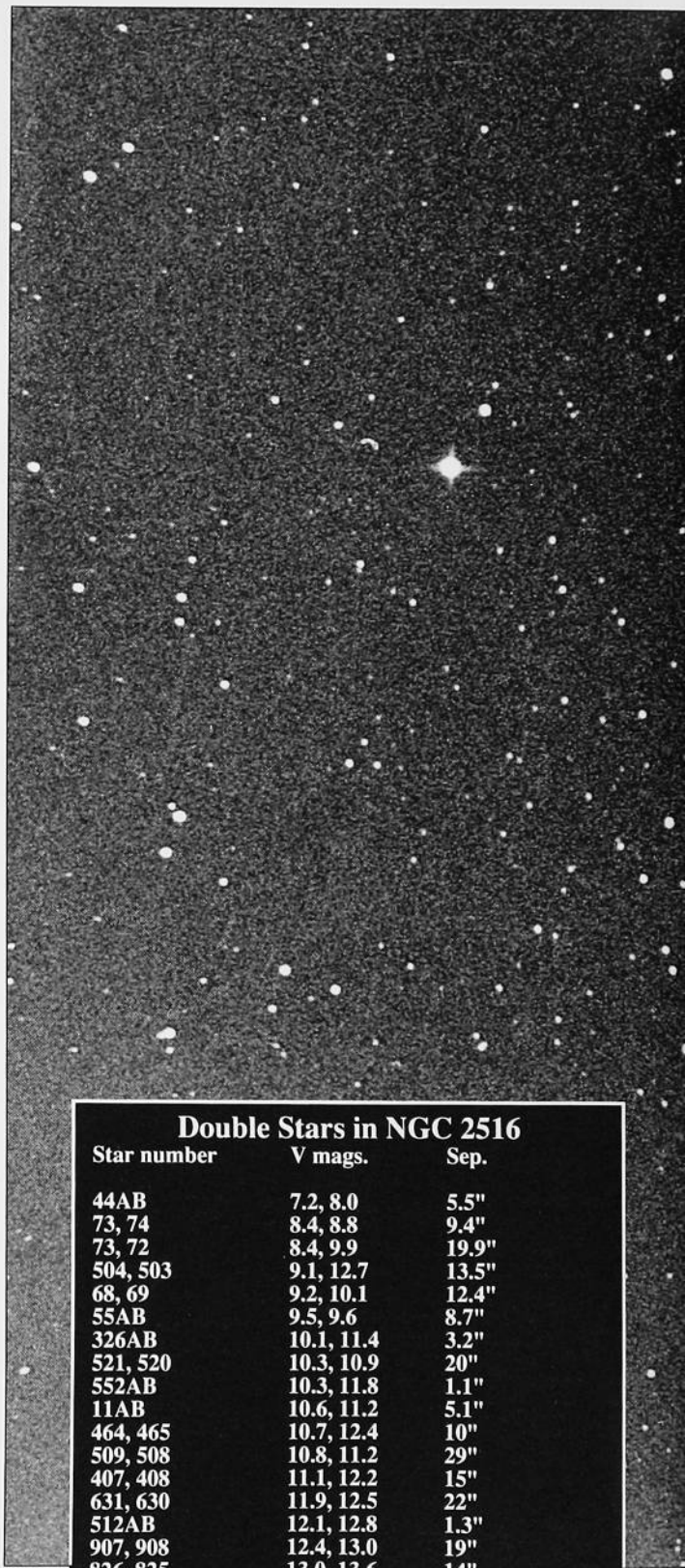
The first star, called 44AB here, but first observed by John Herschel and catalogued as h4031, will be a routine pair for the 6-inch at 80x. It is the pair with the most visual interest in the cluster, being by far the brightest and closest on the list.

The pairs 73, 74 and 73, 72 (h4027) are located on the west side of the cluster core and form a wide quadruple (with star 71, V = 11.3) for low powers. At 50x or 80x they could rival h4031 for attention.

The next faintest close pair is 55AB, which is still bright enough to be easy at medium powers. The pair 326AB will be relatively difficult, if only because the components are relatively faint and have a large magnitude difference. Still, high power should do the trick.

The close pair 552AB will not be resolved in my telescope. Ordinarily a pair of this separation would split only if they were brighter than about magnitude 9 or 9.5. I would guess that a 12-inch scope would be needed to see them. The same situation holds for 512AB near the bottom of the list. Its stars are just too faint and too close.

Lowell Observatory
1400 Mars Hill Road West
Flagstaff, AZ 86001



Double Stars in NGC 2516

Star number	V mags.	Sep.
44AB	7.2, 8.0	5.5"
73, 74	8.4, 8.8	9.4"
73, 72	8.4, 9.9	19.9"
504, 503	9.1, 12.7	13.5"
68, 69	9.2, 10.1	12.4"
55AB	9.5, 9.6	8.7"
326AB	10.1, 11.4	3.2"
521, 520	10.3, 10.9	20"
552AB	10.3, 11.8	1.1"
11AB	10.6, 11.2	5.1"
464, 465	10.7, 12.4	10"
509, 508	10.8, 11.2	29"
407, 408	11.1, 12.2	15"
631, 630	11.9, 12.5	22"
512AB	12.1, 12.8	1.3"
907, 908	12.4, 13.0	19"
826, 825	13.0, 13.6	14"

Source: *Astron. & Astrophys. Suppl.* **78:**25, April.

The bright open cluster NGC 2516 photographed by Gregg Thompson with a 10-inch f/5 reflector and a 10-minute exposure.

Variable Stars
Bright Enough for Binoculars
by David H. Levy

Although variable stars are often relegated to the backwaters of telescope observing lists, they should not be. Several types of normally faint variables often reach binocular visibility, and ocassionally they are bright enough to be seen with the naked eye.

If you followed Mira last autumn past its early November maximum, you might have seen it brighten past 3rd magnitude in one of its brightest recent maxima. Some observers recorded it as magnitude 2.8, with the help of magnitude-2.7 Alpha Ceti as a comparison star. Other types of Mira stars also await observers equipped with binoculars.

Mira Stars. As we have already seen with Mira itself, long-period variables ocassionally reach binocular or naked-eye visibility. For example, 210868 **T Cephei** is easy to find some 5° southwest of Beta Cephei. T Cephei has a period of 387 days and a normal maximum magnitude of 6.1. It dips as faint as magnitude 10.1 at minimum.

A fainter maximum occurs with 081112 **R Cancri**. Found just 3° north of Beta Cancri, R Cancri varies over a range of almost five magnitudes to a minimum of 11.2. Because it has a period of 360 days its maxima and minima occur at roughly the same times each year.

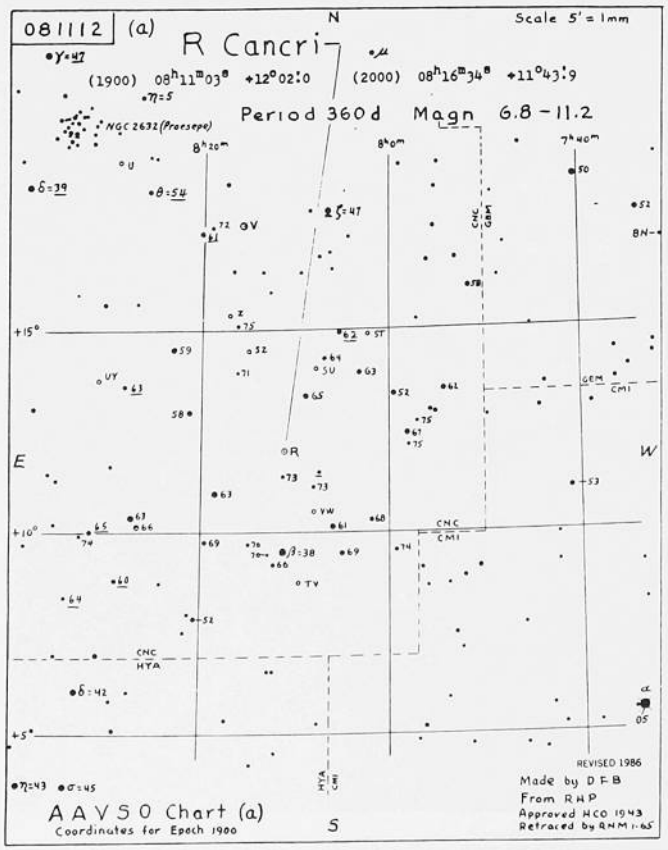
The star 162112 **V Ophiuchi** also reaches binocular visibility. When at its peak of magnitude 7.4, V Oph has a three-magnitude range that leaves it at a minimum of 10.2. This star's period is 297 days. You can find V Oph about 3° southwest of Zeta Ophiuchi, a magnitude-2.7 star.

In late spring try 190108 **R Aquilae**. Its maximum of magnitude 6.0 makes it visible with the unaided eye. This star falls to magnitude 11.4 over a period of 329 days.

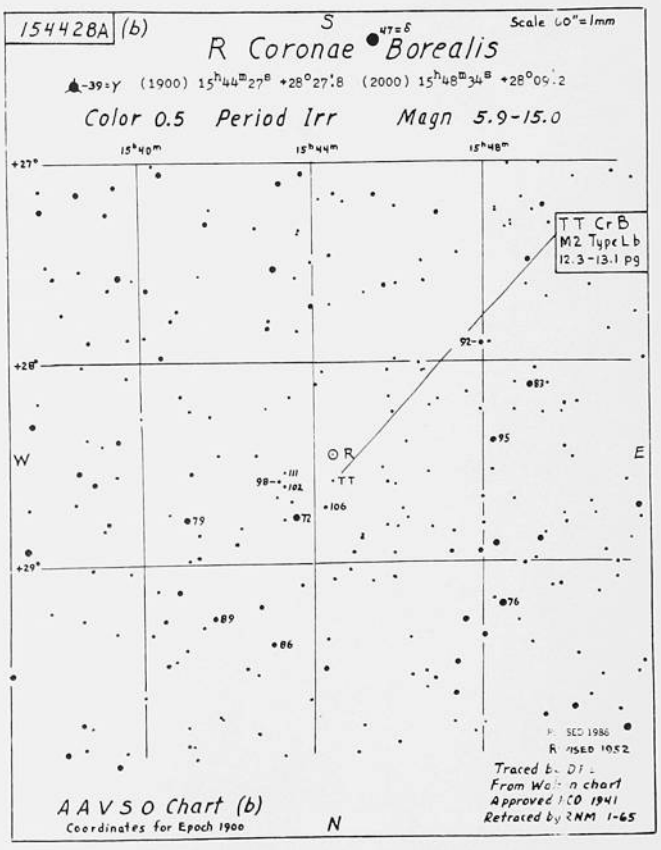
Novae. Another type of bright variable star is the nova. When **Nova Cygni 1975**, later called V1500 Cygni, burst into the late summer sky it surprised many observers who never expected to see an extra star extending the long arm of Cygnus northward. At its maximum Nova Cygni 1975 shone at magnitude 1.6.

Supernovae in the Magellanic Clouds can achieve naked-eye visibility, as we know from 1987A. In our own galaxy a supernova might or might not be easily visible. Events in 1054, 1572, and 1604 produced bright supernovae, but at least one supernova failed to show up visually, its remains visible in this century only by its radio-energy echoes. A similar fate could befall the next galactic supernova if its light has to contend with large amounts of interstellar dust.

Recurrent novae are eruptive stars that repeatedly flare up as time progresses. 155526 **T Coronae Borealis** erupted in 1866 and again in 1946, rising quickly from 10th to 2nd magnitude. This star is worth watching every night since its outbursts take place with almost no warning. The spring sky offers another recurrent nova, 174406 **RS Ophiuchi**. This star erupts more frequently than T Cor Bor. It was last discovered



This finder chart for R Cancri shows a binocular view of the surrounding area. Charts courtesy Janet Mattei, AAVSO.



A telescopic chart for R Coronae Borealis.

in outburst by Canadian observer Warren Morrison.

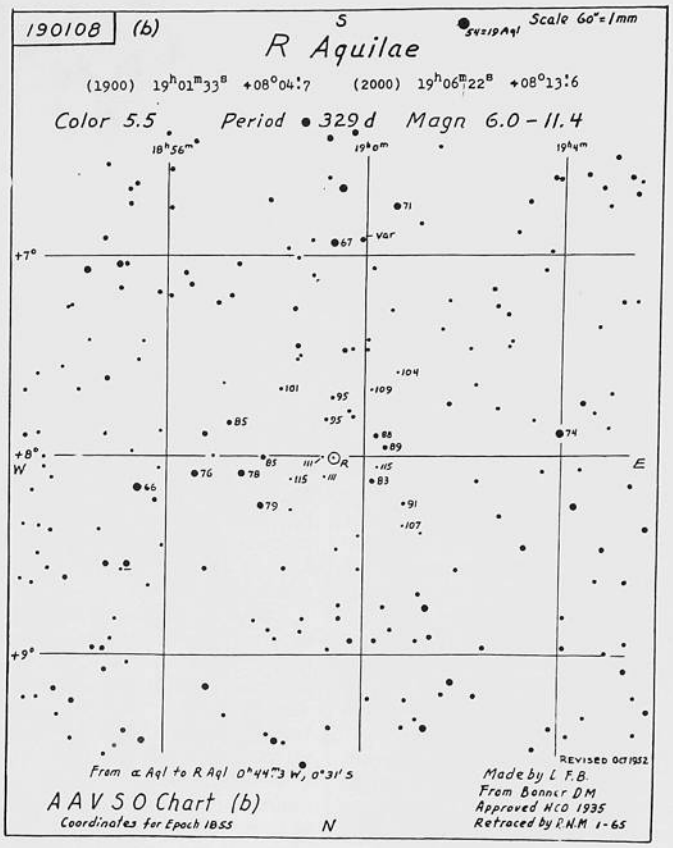
Semiregular Stars. I ocassionally wonder why this class of stars is called "semiregular." Is the star regular from maximum to minimum but, off the wall as it tries to get back to maximum? Or is the star regular around maximum and irregular around minimum? Or what?

Semiregular stars are assigned periods and maxima and minima but these values vary irregularly within these bounds. Sometimes their periods are much longer or shorter than predicted. Sometimes their maxima are bright or their minima faint. And sometimes they become stuck in a certain place for an extended period.

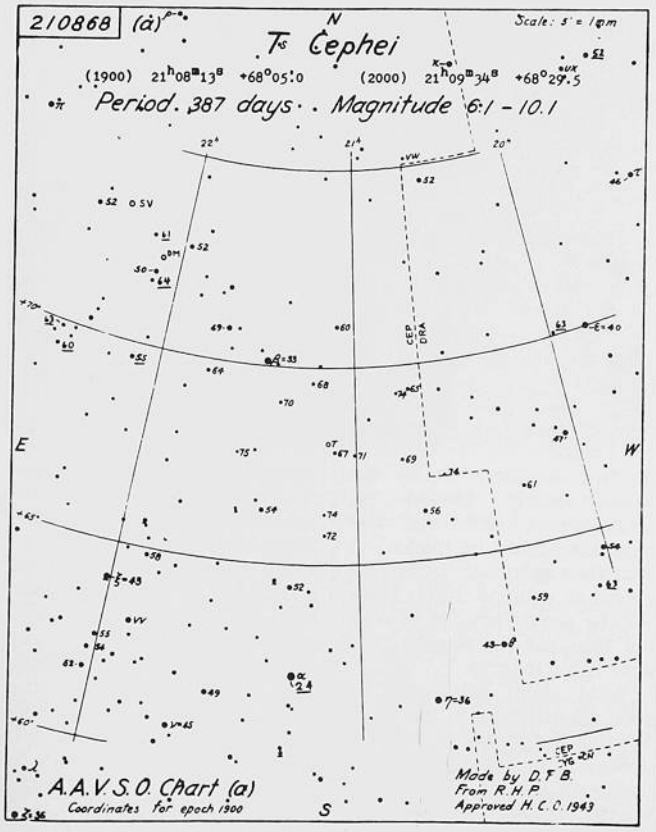
Because semiregular stars are usually intrinsically luminous, many of them are bright enough to be followed using binoculars. One of my favorites is 053068 **S Camelopardalis**, a star with a maximum magnitude of 8.3 and a minimum of 10.6. It varies over approximately 328 days. With a spectral type of R8, S Cam is a very red star, which is not untypical of semiregulars. Brighter yet is the star 050001 **W Orionis**, which is visible in the western sky on spring evenings. Its entire range between magnitudes 5.9 and 7.7 is visible through binoculars (even from an urban sky) over a period of about 200 days. Much further east is 084917 **X Cancri**, a bright star with a maximum magnitude of 5.9 and a minimum of 7.3. Although the star's period of 165 days is quite uncertain since X Cnc behaves unpredictably. In the same constellation lies **RT Cancri**, which has a magnitude range of 7.3 to 8.6, making it quite a bit fainter than X Cnc. RT Cancri's period is nominally 94 days.

Finally, yet another note on 154428 **R Coronae Borealis**. In 1988 and 1989 I discussed this star's precipitous decline in brightness from its magnitude 5.9 maximum and its subsequent rise. In 1989 the star had another descent from maximum, although this one was shallower. R Coronae bears continued watching every few nights.

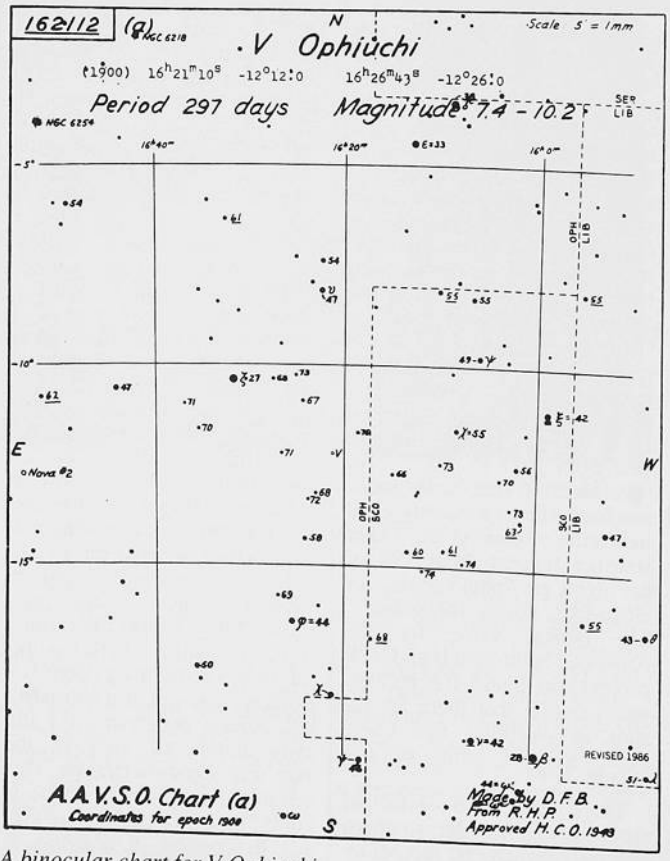
120 William Carey Drive
Tucson, AZ 85747



A telescopic chart for R Aquilae.



A binocular chart for T Cephei.



A binocular chart for V Ophiuchi.

Scanning the Literature

Three Weeks in Paradise

by Brian Skiff

By the time you read this I will have returned from a three-week visual observing run at Las Campanas Observatory in Chile. This observatory is operated by the Carnegie Institution of Washington, but houses telescopes from the University of Toronto as well. The site is located on the fringes of the Atacama Desert in the Andean foothills at an altitude of about 2,300 meters or 7,500 feet. The austral summer weather is often perfect for weeks on end, and my observing plans had to assume that every night was going to be cloudless with transparency comparable to mountain sites in the American Southwest.

Leaving aside for the moment the question of why I might want to spend a lot of money to take a 6-inch telescope to Chile for three weeks, let's think about how to plan such an opportunity for observing deep-sky objects.

Eventually, it would be nice to be able to cover all of the southern sky from this excellent site. But for starters, you'd like to go when you could expect most clear nights per dollar. Weather statistics covering fifteen years are published for Cerro Tololo Inter-American Observatory (CTIO), the U.S. national observatory's southern hemisphere site, located about 50 miles south of Cerro Las Campanas. These indicate the months November through February are nearly perfect; no rain at all fell at CTIO in December or January in any year from 1971 to 1985! "No rain" doesn't necessarily mean no clouds, but it's a pretty good indication of clear skies. Other statistics suggest about 85% of the nights are "photometric," or cloud-free, during the season. The typical value for the American Southwest is about 30 percent year-round. It is perhaps worth noting that there are no sites in Australia that come even close in terms of sky quality.

There are two principal attractions in the far southern sky for Northerners: the Milky Way in the Vela-Norma region, and the Magellanic Clouds. Although a 6-inch telescope will show a large number of objects in both clouds, there are only a few real showpieces; the southern Milky Way, on the other hand, is full of them! "Cloud season" is the early austral summer, when both galaxies culminate during the course of one night. The far-southern Milky Way is best placed in February or March. Checking a calendar, I saw that New Moon fell in late February 1990, which is just right.

I made arrangements with the observatory to bring my telescope down and stay on the mountain, which required convincing them I wasn't a total wacko, and then began to make up an observing list. A little calculation showed that during the course of a night I would be able to view objects between about 6h and 16h right ascension without straying more than an hour or two off the meridian. A look at the Tirion *Sky Atlas 2000.0* charts covering the region south of -30° declination shows this swarth of sky to be the most varied anywhere on the celestial sphere. Not only is the Milky Way dense with objects, but galaxies appear in significant numbers. Where to start?

On the assumption that this will be may only trip, I wanted to be as complete as possible. How many objects could I observe in the allotted time, compensating for moonlight, but assuming every night to be clear? I pulled out my most recent logbooks, which contain observing notes made in the last two years with my 6-inch refractor. Often I note the start and end times of a viewing session, which allowed me to calculate the number of objects viewed per hour in a circumstance where I wasn't hurrying. Several sessions where I worked only on ordinary deep-sky objects came out at a consistent six objects per hour; if I did only double-star viewing, the rate was somewhat faster. This ten-minutes-per-object rate is for a thorough, quantitative verbal description; a drawing in addition (rare for me) means another twenty minutes at least. But I'm only going once, so I ought to make at least some sketches. Adding up the nighttime hours during the run and multiplying by six gave a number close to 900. While the Moon is up, I can view double stars, which I can knock off quickly. Maybe a thousand objects total during the three weeks.

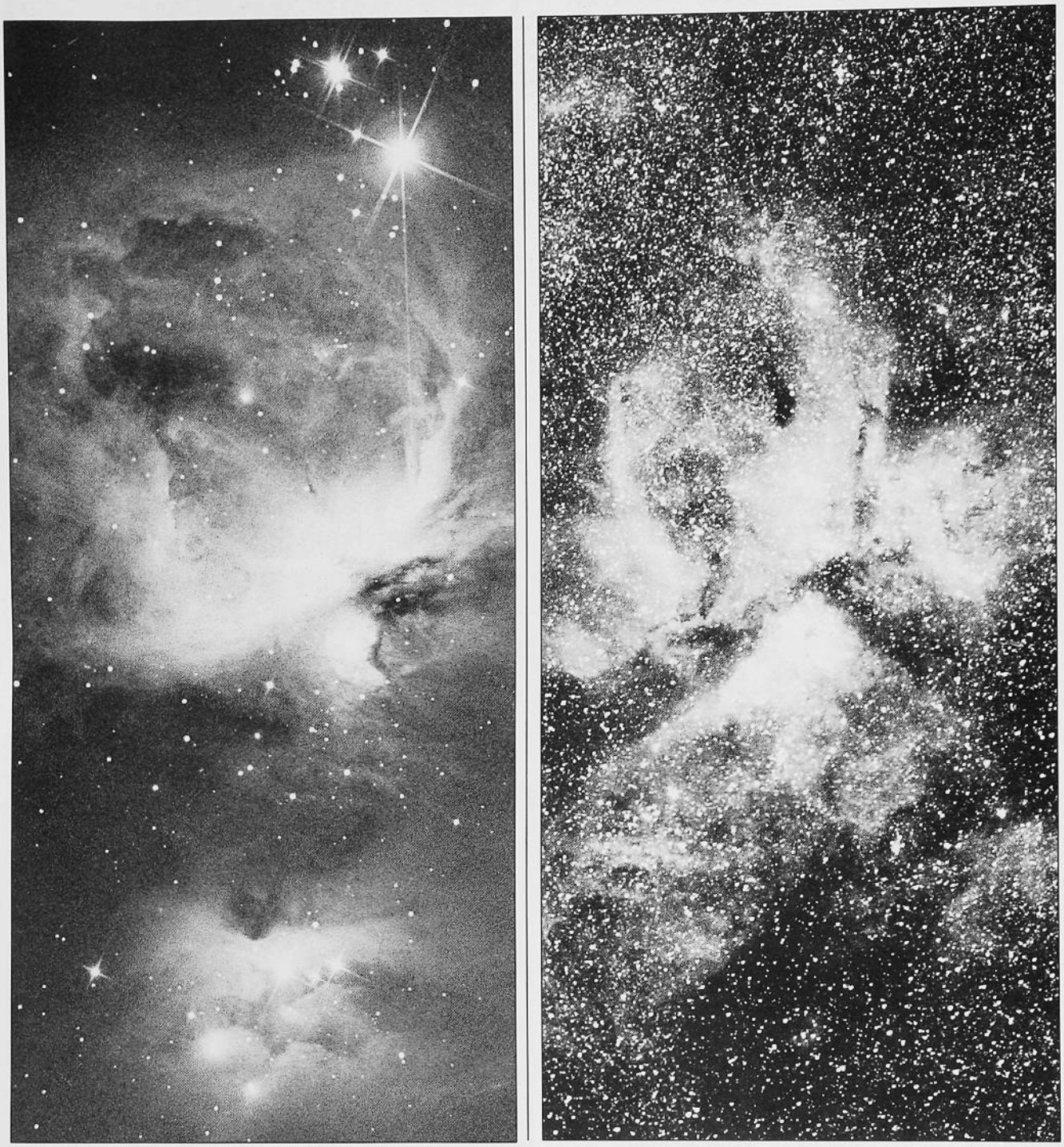
The only observing guide to the southern hemisphere of any substance is E. J. Hartung's *Astronomical Objects for Southern Telescopes*. In it are descriptions of a thousand objects, but nearly half are double stars, leaving only the showpiece deep-sky objects. Thus in order to make a complete list, I turned to the basic catalogues pertaining to each class of object.

I knew that, unlike in the north, the most numerous objects in the available wedge of right ascension were open clusters, not galaxies. Given the limits of the 6-inch, how could these be chosen? The obvious way would be to look on a photographic atlas and pick out all the reasonably bright ones. Another method would be to go by total magnitudes: most of the bright southern objects have been observed photometrically, so total magnitudes are published in places like *Sky Catalogue 2000.0*. (Oh yeah, I did all that work!) This led me to examine my collection of articles with cluster charts and magnitudes for stars in the field, and by selecting those with stars brighter than, say, magnitude 13, I made a list of over three hundred clusters. Nearly all were already plotted on *Uranometria*, and the few remaining could be marked in once their coordinates were precessed to equinox 2000. There will be some marginal objects, but they can be skipped over once found to be so.

What about galaxies? The southern extension of the Virgo Supercluster appears in my window, ending only because the Centaurus Milky Way blocks out the most southerly galaxies. About the time my planning started, the photometry catalogue of the ESO survey galaxies by Lauberts and Valentijn came out (see this column in the Autumn 1989 issue). This allowed me to select galaxies down to well-defined limits both in total magnitude and surface brightness. From a true-dark site, the 6-inch has no difficulty with galaxies of normal surface brightness at total B (blue) magnitude 12.5 [or V (visual) ~11.5-11.7]. (If it wasn't obvious, Las Campanas has zero light pollution.) I scanned the ESO catalogue for such objects and found about 85 within the observing window. Those won't take very long to observe, I thought, let's go another half-magnitude fainter. By magnitude 13.0 there are nearly double the number of galaxies.

Then there are four bright galaxy clusters: Hydra, Antlia, IC 4396, and NGC 4696, the last two lying in Centaurus. For these small regions I decided to go down to total B magnitude 14.0; the faintest will be little more than weak smudges, but it'll be a good start for seeing how interesting these clusters will be in a larger telescope. These bring the total to about 225 galaxies, about 90% of which are plotted on *Uranometria*.

The next category is the planetary nebulae. The existing observing guides and even the standard catalogue by Perek & Kohoutek provide practically no guidance. Nobody has ever done a thorough visual survey in light of modern spectroscopic surveys for these objects. About all I could do was to go through the finder charts in the P&K catalogue and select objects that looked reasonably bright. I happened to have a list of true-visual magnitudes for southern planetaries derived by Jack Marling: comparing lists, I was able to cross off a few dozen as being too faint for the 6-inch, even among the stellar objects. This left about 85 nebulae. Many of those that remain will probably not show up in the 6-inch even with sky-supressing "nebula" filters, but the only way to find out is to go and look for a lot of planetaries for which nothing is known except the



Skiff's Las Campanas observing run will afford the opportunity to make a rare comparison: side-by-side views of the Orion Nebula (left) and the Eta Carinae Nebula. Orion Nebula photo by Martin C. Germano (8-inch f/5 reflector, 103a-F film, 25-minute exposure); Eta Carinae photo by Jean Dragesco (300mm f/1.5 Schmidt camera, hypered Tech Pan film, 7-minute exposure).

position!

Diffuse galactic nebulae are another problem: again there is no guidance in print. I'll first have to check all the NGC/IC objects and as many others as look reasonably bright on photographs published in books and magazines. It will not be very many objects in any case. It will be most interesting, however, to compare the Orion Nebula and the Eta Carinae Nebula "side-by side."

Globulars. There are hardly any; I added all the NGC/IC objects to the observing list.

While the Moon is up, I'll bag double stars selected the same way as I have in the north, and have discussed in the Winter 1989/90 issue.

My *modus operandi* will be to start at the south pole, which is even more boring than the northern one, and work east and north each night as the Moon recedes (I'll be arriving just after Full Moon). Since I've marked all the targets on my copy of *Uranometria*, I can work directly from the charts, star-hopping from object to object. If all goes well, I plan to work as far as the Uranometria zone covering up to -27° Dec. It would be nice to go to -20°, but that adds a large amount of sky (and many objects) to the survey; there won't be time. If the sky, my stamina, and time permit, I'll more likely extend the survey on the east and west sides rather than on the north. If there are few cloudy night, I'll generate something like 200 pages of notes: a year's worth of observations in one dark run!

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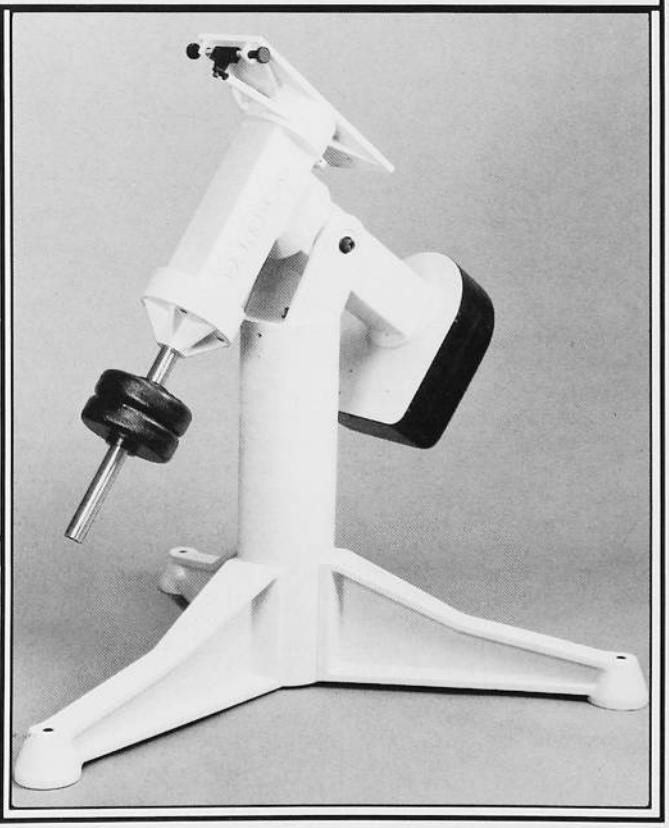

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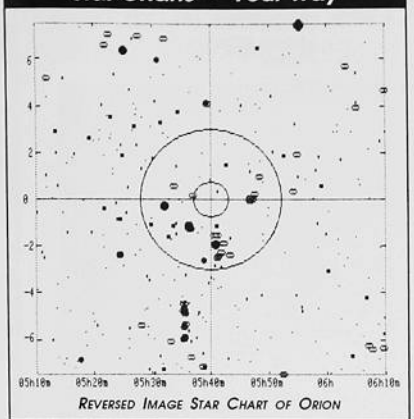

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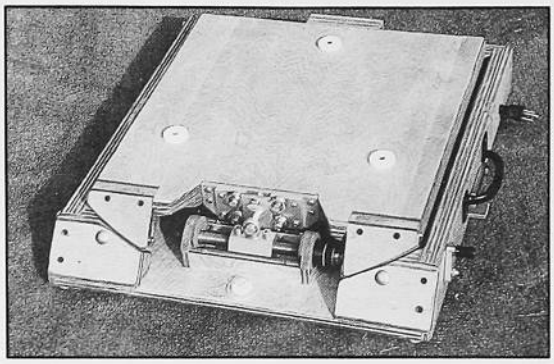

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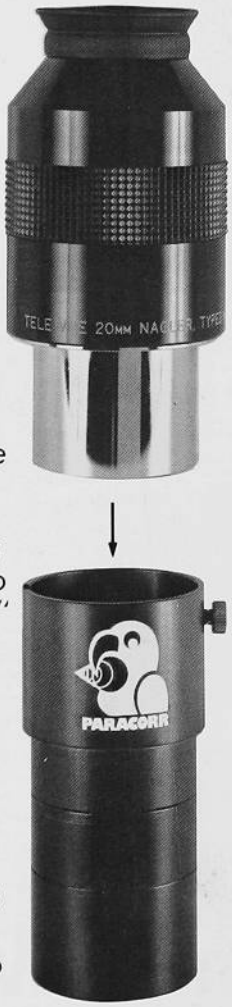

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